APPENDIX

Response to Bernard E. Souw Appendix Attached to May 12, 2005 Advisory Action in U.S. App'n Ser. No. 09/669,877

The anonymous group of PTO officials and other unknown members that constitute the Secret Committee responsible for handling this and other BlackLight applications have relied heavily on arguments presented by Examiner Souw in various Appendices attached to previous Office Actions. Applicant responded by filing his own Appendices that raised points discrediting those arguments and further highlighting the Committee's failure to seriously consider Applicant's scientific evidence proving the existence of lower-energy hydrogen. Many of those points stand unrebutted and, therefore, weigh heavily in favor of allowing the pending claims in this case to issue.

In an attempt to counter a few of those points, the Committee now responds with additional arguments presented by Examiner Souw in yet another Appendix attached to the present Advisory Action, which still does little to advance the prosecution of this application. [Souw Appendix IV] To the contrary, these newly presented arguments expose an even greater disregard for Applicant's scientific evidence, in which Examiner Souw: (1) misstates proper standards for evaluating that evidence, thereby unfairly creating new standards; (2) misinterprets experimental data (even misreading a simple figure); and (3) misunderstands basic scientific concepts resulting in the improper invalidation of Applicant's evidence, such as his XPS and water bath calorimetry data.

Applicant's discussion herein tracks all of these arguments and rebuts them point by point, calling into question the extent to which his scientific evidence has received a fair hearing. From this discussion, it is clear that the Examiner, unable to refute that evidence on scientific grounds, resorts to mere hand waving to dismiss the data.[1]

Section 25

[1] In each of the Sections below, the language quoted from Examiner's Souw's Appendix contains typographical errors in regards to the formulae. Given the extremely short time period for responding to the pending Advisory Action, Applicant did not have sufficient time to correct the formulae. Thus, when in doubt as to the correct formulae, please refer to the original text of his Attachment.

In the Section of Examiner Souw's Appendix entitled "I. Experimental Part," under "(A) General Arguments" the Examiner begins on page 1 by claiming:

> Applicant's alleged "evidence" falls into three categories:
>
> (a) Those published by Applicant himself, his own company Blacklight Power Inc. (hereinafter BLP) and/or its subsidiaries, including companies paid by BLP to do work on BLP's behalf, all of which report results which are in contradiction to those obtained by independent third parties. In this regard, **all** attempts carried out by independent third parties to reproduce Applicant's claimed results have failed [1, 2]. Thus, Applicant's publications of this category are not considered as supports for the patentability of the present invention, since their results are deemed incredible. Falling under this category are publications nos. 7, 13-15 (sponsored by BLP), 17, 20-43 and 46-47.

As given in Section Nos. 20-24 of Applicant's main response, the results of Cvetanovic and possibly the results of Jovicevic et al. actually confirm Applicant's results. Furthermore, it is absurd to imply that the very prestigious researchers and research institutions that are listed in the 51 independent validations provide in the section entitled "Independent Test Results" are falsifying data or providing misleading statements. The only evidence of such is that of the detractors as given in Section 21 of Applicant's main response.

Section 26

The second evidentiary category identified by Examiner Souw on page 1 of his Appendix is:

> (b) Those published in non-peer-reviewed journals, as already identified in previous Office Action(s)

Applicant's results are published in over 60 peer-reviewed journal articles and the remaining are expected to be published as well. The Examiner's refusal to recognize this fact merely confirms his bias, as discussed at length in Applicant's main response.

Section 27

The third and final evidentiary category identified by Examiner Souw on page 2 of his Appendix is:

> (c) Those claiming observations unrelated and/or irrelevant to hydrino, such as excessive line broadening, novel peaks (either plasma or solid state spectroscopy), excess heat, enhanced radiation, i.e., phenomena explainable by conventional physics (e.g., impurities that evidently disappeared after surface cleaning [3]), while totally lacking any hard evidence (such as material hardness measurement), as already identified in previous Office Actions. To this category belong publications nos. 1-6, 8-12, 16, 18-19, 44, and 45.

Here again, the Examiner shows his bias. All of the results presented by Applicant confirm his technology.

Excessive line broadening cannot be explained by conventional methods, such as field acceleration, and demonstrates the energetic reaction of hydrogen to lower-energy states. See:

51. J. Phillips, C-K Chen, R. Mills, "Evidence of catalytic Production of Hot Hydrogen in RF Generated Hydrogen/Argon Plasmas", IEEE Transactions on Plasma Science, submitted.
109. R. L. Mills, M. Nansteel, J. He, B. Dhandapani, "Low-Voltage EUV and Visible Light Source Due to Catalysis of Atomic Hydrogen", J. Plasma Physics, submitted.
108. R. L. Mills, J. He, M. Nansteel, B. Dhandapani, "Catalysis of Atomic Hydrogen to New Hydrides as a New Power Source", International Journal of Global Energy Issues (IJGEI), Special Edition in Energy Systems, submitted.
81. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", European Physical Journal-Applied Physics, Vol. 28, (2004), pp. 83-104.
54. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.
51. R. Mills, P. Ray, R. M. Mayo, "CW HI Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.

49. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 3, (2003), pp. 338-355.
46. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population and a Very Stable Novel Hydride Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Catalysts", Optical Materials, Vol. 27, (2004), pp. 181-186.
42. R. L. Mills, P. Ray, "A Comprehensive Study of Spectra of the Bound-Free Hyperfine Levels of Novel Hydride Ion $H^{-}(1/2)$, Hydrogen, Nitrogen, and Air", Int. J. Hydrogen Energy, Vol. 28, No. 8, (2003), pp. 825-871.

Novel peaks (either plasma or solid state spectroscopy) show the energy levels of hydrino directly. See:

112. R. L. Mills, J. He, Y. Lu, M. Nansteel, Z. Chang, B. Dhandapani, "Comprehensive Identification and Potential Applications of New States of Hydrogen", Central European Journal of Physics, submitted.
111. R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species $H^{-}(1/4)$ and $H_2(1/4)$ as a New Power Source", Thermochimica Acta, submitted.
110. R. L. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrides as a New Power Source," Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem. 2005, 50(2).
67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.

Excess heat-direct measurement of the enthalpy of formation of hydrinos and can not be explained by conventional chemistry. See:

77. J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", Journal of Applied Physics, Vol. 96, No. 6, pp. 3095-3102.

"Enhanced radiation" with over 1000 times more light is observed for power input than in a conventional light source, which confirms the power source of the catalysis of hydrogen to lower-energy states. See:

52. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
20. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
16. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.

Examiner Souw's comment that Applicant's observations are simply "phenomena explainable by conventional physics (e.g., impurities that evidently disappeared after surface cleaning [3])," has no basis. As Applicant has demonstrated, conventional physics can not explain these observations

Similarly, the Examiner's further statement claiming that Applicant's observations are "totally lacking any hard evidence (such as material hardness measurement), as already identified in previous Office Actions," also lacks merit. Applicant has provided data on novel properties, such as extraordinary stability to oxidation

61. R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", Solar Energy Materials & Solar Cells, Vol. 80, No. 1, (2003), pp. 1-20.

and behavior of hydrides as organic molecules in chromatographic analysis and extraordinary stability in water:

38. R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydrides from Aqueous Electrolysis and Plasma Electrolysis", Electrochimica Acta, Vol. 47, No. 24, (2002), pp. 3909-3926.
10. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.
9. R. Mills, "Novel Inorganic Hydride", Int. J. of Hydrogen Energy, Vol. 25, (2000), pp. 669-683.
8. R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis

and Characterization of Novel Hydride Compounds", Int. J. of Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 339-367.

Further, the relationship of the data to hydrino validation is given in the section entitled "Lower-Energy Hydrogen Experimental Data".

Section 28

On page 2 of the Appendix, Examiner Souw draws the outrageous comparison of Applicant's invention to "crop circles," which statements Applicant requests be stricken from the record:

> The Examiner's rejection of "evidences" of category (a) to (c) remains the same, and is summarized as follows:
>
> **(A.1)** Peculiarity or anomaly alone is by far not sufficient as "evidence". There are a great abundance of peculiarities and anomalies in this world, from "irreducibly complex molecular machines" to "**crop circles**". Many are hoaxes, and some are genuine phenomena waiting to be resolved by true science. However, hydrino is here excluded as a possible cause for the peculiarities and anomalies presented on pgs. 1-37, not only because there is no evidence for its existence, but additionally, because the underlying theory, the Grand Unified Theory of Classical Quantum Mechanics, hereinafter GUT, has now been proven totally invalid as a scientific theory (see part II of this Appendix) owing to the incredibly large number of mathematical flaws and violations of known physical laws. There are still many plausible causes instead of the incredible hydrino that may be responsible for the peculiarities and anomalies cited in Applicant papers listed on pgs. 1-37, a few of which have been discussed in previous Office Action(s) and will be consequently prosecuted in the following sections. [Emphasis added.]

Perhaps "crop circles" and hoaxes are high on Examiner Souw's mind since they are akin to aspects of SQM upon which his world view is based and provides the framework (or lack there of) for the interpretation of the real-world evidence provided by Applicant. The Examiner has the theory issue directly reversed. Quantum mechanics involves "spooky actions," virtual particles in every point in space, infinities, polarization of the vacuum, lack of Einstein causality, negative kinetic energy states including infinite

ones, paradoxes, mysteries, postulates, and enigmas. It has as its parameter Psi, which has no physical basis.

In stark contrast, Applicant's work is based on applying Maxwell's equations and Newtonian mechanics as well as special relativity to solve atomic problems. The results of closed-form equations with fundamental constants only that match 100's of observables can not be matched by SQM, which is merely a non predictive exercise in curve fitting with computers. Furthermore, the data presented by Applicant overwhelmingly confirms hydrino by direct spectral identification and by the identification of the conjugate observables associated with its formation.

Results include confirmation by at least 11 different techniques that are all showing different aspects of the same thing: a powerful reaction of atomic hydrogen and the formation of hydrino. These include: (1) a match between the catalysts and the observed emission for the hydrino reaction, (2) signatures of energetic reactions, including extraordinarily hot hydrogen atoms, the predicted formation of plasma, and energetic pumping (excitation) of hydrogen states, (3) large heat of the formation of hydrino, (4) the spectral emission of lower-energy hydrogen atoms, (5) the spectral emission from vibration and rotation of the hydrino molecule, (6) the observation of the corresponding hydrino hydride ion by emission spectroscopy that can not be assigned to any known species, (7) the predicted NMR signature from the hydride ion and the corresponding gas molecule, (8) the binding energy of the molecule and the hydride ion measured by mass spectroscopy and X-ray photoelectron spectroscopy, respectively, (9) the rotational emission of the molecules trapped in the hydride compounds with electron-beam excitation, (10) the isolation and characterization of chemical compounds containing the new hydrides ions that show extraordinary properties and analytical signatures, and most significantly, (11) the exact spectrum predicted for the single-rotational transition of hydrino molecules trapped in the solid compounds. The energies, intensities, line widths, and peak spacing match theory identically, and the

results match the body of other evidence from independent techniques. A summary is given in the section entitled "Lower-Energy Hydrogen Experimental Data".

See Applicant's papers such as:

111. R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species $H^-(1/4)$ and $H_2(1/4)$ as a New Power Source", Thermochimica Acta, submitted.

ABSTRACT

The data from a broad spectrum of investigational techniques strongly and consistently indicates that hydrogen can exist in lower-energy states then previously thought possible. The predicted reaction involves a resonant, nonradiative energy transfer from otherwise stable atomic hydrogen to a catalyst capable of accepting the energy. The product is $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n=\frac{1}{2},\frac{1}{3},\frac{1}{4},\ldots,\frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. He^+, Ar^+, and K are predicted to serve as catalysts since they meet the catalyst criterion—a chemical or physical process with an enthalpy change equal to an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. Specific predictions based on closed-form equations for energy levels were tested. For example, two $H(1/p)$ may react to form $H_2(1/p)$ that have vibrational and rotational energies that are p^2 times those of H_2 comprising uncatalyzed atomic hydrogen. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$.

The predicted products of alkali catalyst K are $H^-(1/4)$ which form $KH*X$, a novel alkali halido (X) hydride compound, and $H_2(1/4)$ which may be trapped in the crystal. The ^1H MAS NMR spectrum of novel compound $KH*Cl$ relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 ppm corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $H^-(1/p)$ with p = 4. The predicted frequencies of ortho and para-$H_2(1/4)$

were observed at 1943 cm^{-1} and 2012 cm^{-1} in the high resolution FTIR spectrum of $KH*I$ having a -4.6 ppm NMR peak assigned to $H^-(1/4)$. The 1943/2012 cm^{-1}-intensity ratio matched the characteristic ortho-to-para-peak-intensity ratio of 3:1, and the ortho-para splitting of 69 cm^{-1} matched that predicted. $KH*Cl$ having $H^-(1/4)$ by NMR was incident to the 12.5 keV electron-beam which excited similar emission of interstitial $H_2(1/4)$ as observed in the argon-hydrogen plasma. KNO_3 and Raney nickel were used as a source of K catalyst and atomic hydrogen, respectively, to produce the corresponding exothermic reaction. The energy balance was $\Delta H = -17,925\ kcal/mole\ KNO_3$, about 300 times that expected for the most energetic known chemistry of KNO_3, and $-3585\ kcal/mole\ H_2$, over 60 times the hypothetical maximum enthalpy of $-57.8\ kcal/mole\ H_2$ due to combustion of hydrogen with atmospheric oxygen, assuming the maximum possible H_2 inventory. The reduction of KNO_3 to water, potassium metal, and NH_3 calculated from the heats of formation only releases $-14.2\ kcal/mole\ H_2$ which can not account for the observed heat; nor can hydrogen combustion. But, the results are consistent with the formation of $H^-(1/4)$ and $H_2(1/4)$ having enthalpies of formation of over 100 times that of combustion.

Section 29

On page 2 of his Appendix, Examiner Souw erroneously summarizes Applicant's scientific evidence as follows:

> To summarize, Applicant's results are either (a) disproved by independent third party researchers (e.g., Marchese et al. [1] and EarthTech [2]; see B.3(c) below), or (b) explained by others as being due to causes other than hydrino (e.g., Fan et al. [3] and Luggenhoelscher [see previous Appendix]).

Marchese et al. validated Applicant's results as reported :

44. **A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.**

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated. See

i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos,

ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths,

iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos,

iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species, and

v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.

EarthTech is also Applicant's competitor; so, their results can not be considered without bias. Many other independent laboratories including INEL, NASA Lewis, MIT Lincoln Labs, Chalk River, and other have validated Applicant's experiments (See the section entitled "Independent Test Results") that were attempted unsuccessfully by EarthTech, which shows that the failure rests on EarthTech, not Applicant's technology.

Regarding Luggenhoelscher, the Examiner is confused. He can not have it both ways by claiming that Luggenhoelscher data does not show an effect as stated in Section 18 of Applicant's main response and here he says that Luggenhoelscher does show line broadening that can be due to some other explanation. The Souw Appendix is full of internal inconsistencies like these, which render the Examiner's analysis null and void.

<u>Section 30</u>

Examiner Souw demonstrates further confusion by arguing on page 3 of the Appendix that:

> Specifically responding to Applicant's statement on pg.17, it is not the Examiner's duty or responsibility to present any alternative explanation; it is sufficient to show that the observed anomaly cannot be due to "hydrino". It is the Examiner's duty and responsibility to reject any <u>mechanism that is scientifically impossible</u>, such as the hypothetical effects due to "hydrino", since there is no evidence that "hydrino" exists, and furthermore, its existence has been proven scientifically impossible. Such a rejection is made possible by the MPEP under 35 U.S.C. § 101 and §112/¶.1.

This statement has no credibility given the evidence summarized in Section 2 of Applicant's main response and Section 28 above. Examiner Souw's statement of "proven scientifically impossible" is not supported by any physical argument since of course energy is released if the electron transitions to an orbit closer to the nucleus. The Examiner is only left with the absence of the prior discovery and unfound theoretical arguments as described in Sections 1-4 of Applicant's main response. The latter is probably responsible for the former.

<u>Section 31</u>

The Examiner continues his biased analysis of Applicant's evidence by stating on page 3 of the Appendix:

> **(A.2)** Applicant's "evidence" is unpersuasive, because NONE of them is hard evidence, but all are invariably argued over some anomalies, such as excessive line broadening, anomalous peaks (in either plasma or solid state spectroscopy), excess heat, enhanced radiation, etc., which do not count, and hence, unpersuasive.

Applicant's experimental evidence provides direct identification of lower-energy hydrogen, with many conjugate parameters, as discussed in Section 2 of Applicant's main response and in Sections 27-28 above.

Section 32

Examiner Souw attempts to further disparage Applicant's evidence on page 3 of the Appendix, but succeeds only in revealing his own analytical shortcomings in the process:

> Regarding evidence, a claim of strong bonding must be validated by <u>measurement of material hardness</u>, but not through unpersuasive arguments over <u>peculiar lines that are irrelevant for being hardly above the noise level</u>, as done by Applicant.

The Examiner's position is nonsensical. Nitrogen, for example, has a very high bond energy, but is not hard. Applicant has measured the bonding in lower-energy hydrogen by the "gold standard," vibration-rotational spectroscopy. See

112. **R. L. Mills, J. He, Y. Lu, M. Nansteel, Z. Chang, B. Dhandapani, "Comprehensive Identification and Potential Applications of New States of Hydrogen", Central European Journal of Physics, submitted.**

> The data from a broad spectrum of investigational techniques strongly and consistently indicates that hydrogen can exist in lower-energy states then previously thought possible. Novel emission lines with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein

$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ..., \frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter n = integer in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to He^{+} acting as a catalyst. Ar^{+} and K also serve as catalysts since, like He^{+}, they meet the catalyst criterion—a chemical or physical process with an enthalpy change equal to an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$.

Two $H(1/p)$ may react to form $H_2(1/p)$ that have vibrational and rotational energies that are p^2 times those of H_2 comprising uncatalyzed atomic hydrogen. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$. The predicted products of alkali catalyst K are $H^-(1/4)$ which form a novel alkali halido hydride compound ($MH*X$) and $H_2(1/4)$ which may be trapped in the crystal. The ^1H MAS NMR spectrum of novel compound $KH*Cl$ relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 ppm corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $H^-(1/p)$ with p = 4. The predicted catalyst reactions, position of the upfield-shifted NMR peaks for $H^-(1/4)$, and spectroscopic data for $H^-(1/4)$ were found to be in agreement with the experimental observations as well as previously reported analysis of $KH*Cl$ containing this hydride ion.

The predicted frequencies of ortho and para-$H_2(1/4)$ were observed at 1943 cm^{-1} and 2012 cm^{-1} in the high resolution FTIR spectrum of $KH*I$ having a -4.6 ppm NMR peak assigned to $H^-(1/4)$. The 1943/2012 cm^{-1}-intensity ratio matched the characteristic ortho-to-para-peak-intensity ratio of 3:1, and the ortho-para splitting of 69 cm^{-1} matched that predicted. $KH*Cl$ having $H^-(1/4)$ by NMR was incident to the 12.5 keV electron-beam which excited similar emission of interstitial $H_2(1/4)$ as observed in the argon-hydrogen plasma. $H_2(1/p)$ gas was isolated by liquefaction of plasma gas at liquid nitrogen temperature and by decomposition of compounds ($MH*X$) found to contain the corresponding hydride ions $H^-(1/p)$. The $H_2(1/p)$ gas was dissolved in $CDCl_3$ and characterized by ^1H NMR. Considering solvent effects, singlet

peaks upfield of H_2 were observed with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm which matched the consecutive series $H_2(1/2)$, $H_2(1/3)$, $H_2(1/4)$, $H_2(1/5)$, $H_2(1/6)$, and $H_2(1/7)$, respectively.

Excess power was absolutely measured from the helium-hydrogen plasma. For an input of 41.9 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.1 W corresponding to 20.2 W of excess power in 3 cm^3 plasma volume. The excess power density and energy balance were high, $6.7\ W/cm^3$ and $-5.4\ X10^4\ kJ/mole\ H_2$ ($280\ eV/H\ atom$), respectively. In addition to power applications, battery and propellant reactions are proposed that may be transformational, and observed excited vibration-rotational levels of $H_2(1/4)$ could be the basis of a UV laser that could significantly advance photolithography.

111. **R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species $H^-(1/4)$ and $H_2(1/4)$ as a New Power Source", Thermochimica Acta, submitted.**

The data from a broad spectrum of investigational techniques strongly and consistently indicates that hydrogen can exist in lower-energy states then previously thought possible. The predicted reaction involves a resonant, nonradiative energy transfer from otherwise stable atomic hydrogen to a catalyst capable of accepting the energy. The product is $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n=\frac{1}{2},\frac{1}{3},\frac{1}{4},...,\frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. He^+, Ar^+, and K are predicted to serve as catalysts since they meet the catalyst criterion—a chemical or physical process with an enthalpy change equal to an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. Specific predictions based on closed-form equations for energy levels were tested. For example, two $H(1/p)$ may react to form $H_2(1/p)$ that have vibrational and rotational energies that are p^2 times those of H_2 comprising uncatalyzed atomic hydrogen. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$.

The predicted products of alkali catalyst K are $H^-(1/4)$ which form $KH*X$, a novel alkali halido (X) hydride compound, and $H_2(1/4)$ which may be trapped in the crystal. The ^1H MAS NMR spectrum of novel compound $KH*Cl$ relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 ppm corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $H^-(1/p)$ with p = 4. The predicted frequencies of ortho and para-$H_2(1/4)$ were observed at 1943 cm^{-1} and 2012 cm^{-1} in the high resolution FTIR spectrum of $KH*I$ having a -4.6 ppm NMR peak assigned to $H^-(1/4)$. The 1943/2012 cm^{-1}-intensity ratio matched the characteristic ortho-to-para-peak-intensity ratio of 3:1, and the ortho-para splitting of 69 cm^{-1} matched that predicted. $KH*Cl$ having $H^-(1/4)$ by NMR was incident to the 12.5 keV electron-beam which excited similar emission of interstitial $H_2(1/4)$ as observed in the argon-hydrogen plasma. KNO_3 and Raney nickel were used as a source of K catalyst and atomic hydrogen, respectively, to produce the corresponding exothermic reaction. The energy balance was $\Delta H = -17,925\ kcal/mole\ KNO_3$, about 300 times that expected for the most energetic known chemistry of KNO_3, and $-3585\ kcal/mole\ H_2$, over 60 times the hypothetical maximum enthalpy of $-57.8\ kcal/mole\ H_2$ due to combustion of hydrogen with atmospheric oxygen, assuming the maximum possible H_2 inventory. The reduction of KNO_3 to water, potassium metal, and NH_3 calculated from the heats of formation only releases $-14.2\ kcal/mole\ H_2$ which can not account for the observed heat; nor can hydrogen combustion. But, the results are consistent with the formation of $H^-(1/4)$ and $H_2(1/4)$ having enthalpies of formation of over 100 times that of combustion.

110. **R. L. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrides as a New Power Source," Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem. 2005, 50(2).**

Plasmas of certain catalysts such as K^+, Sr^+, and Ar^+ mixed with hydrogen were studied for evidence of a novel energetic reaction. These hydrogen plasmas called resonant transfer- or rt-plasmas were observed to form at low temperatures (e.g. $\approx 10^3\ K$) and an extraordinary low field strengths of about 1-2 V/cm. Time-dependent line broadening of the H Balmer α line was observed corresponding to extraordinarily fast H (25 eV). Intense hydrogen Lyman emission, a stationary inverted Lyman

population, excessive afterglow duration, highly energetic hydrogen atoms, characteristic alkali-ion emission due to catalysis, predicted novel spectral lines, and the measurement of a power beyond any conventional chemistry were also observed. Using a number of spectroscopic and analytical techniques, the reaction products were identified as atoms with energies that are an extension of the Rydberg series to lower states as well as the corresponding molecules and hydride ions. The results show the feasibility of this highly exothermic reaction as a new energy source.

Examiner Souw's refusal to fairly consider this significant evidence displays a level of arrogance that permeates his entire analysis and exposes its glaring weaknesses.

Section 33

In his continued assault on Applicant's scientific evidence, Examiner Souw makes further misstatements on Appendix page 3 that:

> NONE of the experiments done by other independent third party researchers has been able to reproduce Applicant's claimed results [1, 2] (see B.3 .b) below).

This is not true as shown by the 51 independent validations summarized with a listing of the researchers and laboratories in the section entitled "Independent Test Results." Examiner Souw's misstatement merely demonstrates the incompleteness of his analysis based on a disturbing unfamiliarity with the contents of Applicant's submitted evidence.

Section 34

The Examiner continues on pages 3 of the Appendix with the erroneous statement that:

> **(A.3)** **All** of the alleged evidences are only argued based on the fractional energy level of hydrogen, for which there is no theoretical justification (see Part II of this Appendix: Theory).

Nothing could be further from the truth. Essentially all elements were experimentally identified before there was any theory to model their characteristics, including the nonphysical, non-predictive, curve-fitting SQM theory. Applicant's CQM is the first to predict novel lower-energy states of hydrogen. The data confirms the catalysis of hydrogen to these lower-energy states and identifies lower-energy hydrogen. Specially, studies that experimentally confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ($n = 1$) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds are summarized in the section entitled, "Lower-Energy Hydrogen Experimental Data" and include including:

extreme ultraviolet (EUV) spectroscopy,[2]
characteristic emission from catalysis and the hydride ion products,[3]
lower-energy hydrogen emission,[4]
plasma formation,[5]
Balmer α line broadening,[6]
population inversion of hydrogen lines,[7]
elevated electron temperature,[8]
anomalous plasma afterglow duration,[9]
power generation,[10]
excessive light emission,[11] and
analysis of chemical compounds.[12]

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[2] Reference Nos. 11-16, 20, 24, 27-29, 31-36, 39, 42-43, 46-47, 50-52, 54-55, 57, 59, 63, 65-68, 70-76, 78-79, 81, 83, 85, 86, 89, 91-93, 95-96, 98, 101, 104, 108-112.

[3] Reference Nos. 24, 27, 32, 39, 42, 46, 51-52, 55, 57, 68, 72-73, 81, 89, 91, 108.

[4] Reference Nos. 14, 28-29, 33-36, 50, 63, 67, 70-71, 73, 75-76, 78-79, 86-87, 90, 92, 93, 98, 101, 104, 110-112.

[5] Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93, 108, 109.

[6] Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97, 105, 108, 109.

[7] Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91.

[8] Reference Nos. 34-37, 43, 49, 63, 67, 73.

[9] Reference Nos. 12-13, 47, 81.

[10] Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93, 98, 101, 104, 108, 110-112.

[11] Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72. 109

<u>Section 35</u>

In the Section of the Appendix entitled "(B) <u>Specific Arguments</u>," on page 4, Examiner Souw commits further errors in analysis, claiming:

(B.1) Pg.29

> Regarding Applicant's misidentification of the well-known He-II 304 Å line routinely found in solar spectrum as being due to Applicant's non-existent "hydrino" [4] (cited in previous Appendix), the Sun is known to also contain hydrogen and helium. Applicant's attempt to justify Applicant's obvious misidentification of the line by referring to new elements, such as iron, which has no relevance to the disputed 304 Å line, is unpersuasive.

Again, the Examiner has turned a blind eye to the inescapable evidence presented by Applicant. The Novel Lines presented in Ref. [67]: R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542 can be Explained as Electronic Transitions to Fractional Rydberg States of Atomic Hydrogen:

• The novel peaks fit two empirical relationships.

• In order of energy, the set comprising the peaks at $91.2\ nm$, $45.6\ nm$, $30.4\ nm$, $13.03\ nm$, $10.13\ nm$, and $8.29\ nm$ correspond to energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,7,9,\ or\ 11$.

• In order of energy, the set comprising the peaks at $63.3\ nm$, $37.4\ nm$, $20.5\ nm$, and $14.15\ nm$ correspond to energies of $q \cdot 13.6 - 21.21\ eV$ where $q = 3,4,6,\ or\ 8$.

• Electronic transitions to fractional Rydberg states given by

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[12] Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94, 98, 100, 101, 104, 108, 110-112.

$$E_n = -\frac{e^2}{n^2 8\pi\varepsilon_o a_H} = -\frac{13.598\ eV}{n^2} \qquad n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ..., \frac{1}{p}; \quad p \text{ is an integer}$$

catalyzed by the resonant nonradiative transfer of $m \cdot 27.2\ eV$ would give rise to a series of emission lines of energies $q \cdot 13.6\ eV$ where q is an integer.

• It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. The general reaction is

$$photon\ (h\nu) + He\ (1s^2) \rightarrow He\ (1s^1 2p^1) + photon\ (h\nu - 21.21\ eV)$$

• Then the two empirical series may be combined. The energies for the novel lines in order of energy are $13.6\ eV$, $27.2\ eV$, $40.8\ eV$, $54.4\ eV$, $81.6\ eV$, $95.2\ eV$, $108.8\ eV$, $122.4\ eV$ and $149.6\ eV$. The corresponding peaks are $91.2\ nm$, $45.6\ nm$, $30.4\ nm$ with $63.3\ nm$, $37.4\ nm$, $20.5\ nm$, $13.03\ nm$, $14.15\ nm$, $10.13\ nm$, and $8.29\ nm$, respectively. Thus, the identified novel lines correspond to energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,\ or\ 11$ or these lines inelastically scattered by helium atoms wherein $21.2\ eV$ was absorbed in the excitation of $He\ (1s^2)$ to $He\ (1s^1 2p^1)$.

Alternative explanations for these lines were eliminated as given for example in Ref. [67]: R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542 and Ref. [98]: R. L. Mills, Y. Lu, J. He, M. Nansteel, P. Ray, X. Chen, A. Voigt, B. Dhandapani, "Spectral Identification of New States of Hydrogen", Applied Spectroscopy, submitted.

From Ref. [98]:

These strong emissions are not found in any single gas plasma, and cannot be assigned to the known emission of any species of the single gases studied such as H, H^-, H_2, H_2^+, H_3^+, He, He_2^*, and He^+, known species of the mixture such as He_2^+, HeH^+, HeH, HHe_2^+, and HHe_n^+ and He_n, possible contaminants [1], or doubly excited states [2]. However the

results can be explained by a novel catalytic reaction involving atomic hydrogen [1, 3-6]

From Ref. [67]:

All known possibilities for the series of novel lines were considered. Spectra of species present in helium hydrogen mixtures and possible impurities were evaluated. The only known species in a helium-hydrogen plasmas are H^+, H_2^+, H_3^+, H^-, H, H_2, He_2^*, HeH^+, and remotely possibly HeH. Other exotic possibilities such as He_2^+, HHe_2^+, HHe_n^+ and He_n were eliminated due to the extremely specialized conditions required for their formation such as extremely low temperatures that were unlike those in the helium-hydrogen microwave plasmas [31-32]. The impurities considered were nitrogen, oxygen, carbon dioxide, and water vapor from air, noble gas contaminants, silicon from the quartz tube, and contaminants from the vacuum system.

Regarding hydrogen species as a candidate of the series of novel lines, hydrogen alone has no known emission in this region ($< 77\ nm$) [5-25] as shown in Figure 1. This is a consequence of the binding energies of H, H_2, and H_2^+ being less than 16.3 eV [43-44], and the binding energy of H^- being only 0.75 eV [26]. The reaction to form H_3^+ is exothermic [45]

$$H_2^+ + H_2 \to H_3^+ + H + 1.7\ eV \tag{1}$$

From Eq. (1), the binding energy of H_3^+ can not be more than 22.43 eV, the sum of the binding energy of H_2^+, 16.25 eV (given by the sum of the bond energy of H_2^+, 2.651 eV [44], and the binding energy of H, 13.59844 eV [43]), the bond energy of H_2, 4.478 eV [44], and 1.7 eV. The corresponding emission is 55.3 nm which is outside of the region of the novel series observed in the region < 50 nm. Furthermore, H_3^+ possesses no excited electronic states, and consequently has no observable emission in the ultraviolet or visible regions [27]. H_3^+ can only be observed spectroscopically via vibration-rotational transitions which are in the infrared [27-28].

He_2^* emission is limited to the spectral region > 58.4 nm; thus, it was eliminated [29]. HeH^+ was eliminated since excited states of this ion were predicted to be unstable or only weakly bonding [33]. HeH emission was eliminated as the source of the series of novel peaks due to the extraordinarily low probability that HeH would form under the conditions of the helium-hydrogen microwave discharge. The existence of "bound" excited states of HeH has been shown by emission spectroscopy of HeH

molecules produced by two ways: (1) by reactions of He and H_2^*, and (2) in charge exchange collisions between HeH^+ and alkali vapors [34-35]. Conditions for either of these types of reactions were not present in the helium-hydrogen microwave plasmas. In addition, the known emission spectrum of HeH was not observed. In particular, HeH has broad emission peaks in the regions of 160-180 nm [36] and 200-400 nm [35] that were not observed in the helium-hydrogen plasmas, nor has the series of novel peaks been recorded on HeH emission. In addition, the novel series does not match the theoretical spectrum of attractive excited states that decay to a repulsive ground state. The theoretical emission of excited states belong to a Rydberg series that converges to the electronic ground state of the HeH^+ ion [34-35].

Air contaminants were also eliminated. Plasmas of nitrogen, oxygen, carbon dioxide, or these gases with 2% hydrogen showed no emission in the region < 50 nm as shown in Figure 5 for hydrogen mixed with nitrogen, oxygen, and carbon dioxide. In addition, water vapor present in the oxygen-hydrogen plasma showed no emission in this region. Nitrogen was further eliminated since the intensity of the $N\,I\;^4S-^4P$ peaks of the nitrogen microwave plasma at 113.45 nm and 119.96 nm were 500,000 photons/s; whereas, these peaks were absent from the helium-hydrogen emission recorded with the same sensitivity. The spectrum of nitrogen matched that given in the literature [46] and NIST tables [5]. Similarly oxygen, carbon dioxide, and water vapor (oxygen-hydrogen mixture) were eliminated since O I peaks were observed from each plasma with intensities >100,000 photons/s; whereas, these peaks were absent from the helium-hydrogen emission recorded with the same sensitivity. The peaks that were absent from the helium-hydrogen microwave plasma, but were observed as intense peaks from the oxygen, carbon dioxide, and water vapor microwave plasmas were the O II peak at 83.45 nm and O I peaks at 87.79 nm, 93.5 nm, 99.1 nm, 103.92 nm, 104.09 nm, and 115.21 nm.

Emission of argon, krypton, and xenon as helium contaminants were eliminated. No emission was observed in the region <50 nm for xenon, xenon-hydrogen, krypton, and krypton-hydrogen as shown in Figure 6 for krypton or xenon mixed with hydrogen. In the case of the argon plasma, only known Ar II and III lines were observed at shorter wavelengths as shown in Figure 7. More significantly, the Ar I lines at 93.2 nm, 104.82 nm, and 106.66 nm have an intensities that are about three orders of magnitude that of the Ar II lines at 48.72 nm, 54.76, and 55.68 nm as observed in the argon control and from NIST tables [5]. This and other lines of argon in the region $50-560\ nm$ were not observed.

Neon has peaks at $45.635\ nm$ and $45.527\ nm$. To eliminate the possibility that the $45.6\ nm$ peak shown in Figures 2-4 was due to the presence of neon as an impurity, the EUV spectra ($25 - 50\ nm$) of the helium-hydrogen mixture (98/2%) (top curve) and control neon (bottom curve) microwave discharge cell emission were recorded with a normal incidence EUV spectrometer and a CEM as shown in Figure 8. The novel lines were not observed in the neon control, and a series of Ne II lines were observed only in the control. The neon peaks at $45.635\ nm$ and $45.527\ nm$ were resolved in Figure 8; whereas, the $45.6\ nm$ peak in the helium-hydrogen plasma was about $3\ nm$ broad. Thus, it was not due to neon impurity. More significantly, the Ne I line at 73.58 nm has an intensity that is about three orders of magnitude that of the Ne II line at $45.635\ nm$ and $45.527\ nm$ as observed in the neon control and from NIST tables [5]. This and other lines of neon in the region $50 - 560\ nm$ were not observed.

Silicon from the quartz tube wall was eliminated since emission due to Si I, Si II, or Si III is not possible below 56 nm based on the NIST tables [5]. Emission from silicon was also eliminated since no silicon lines were observed in any spectrum in the 5-560 nm region. Using the same quartz tube run under identical conditions, no emission was observed in the region of the novel series ($< 50\ nm$) in the case of the controls microwave discharge plasmas of hydrogen, nitrogen, oxygen, carbon dioxide, helium, krypton, xenon, or 2% hydrogen mixed with each of these gases except for helium.

Pump contaminants were eliminated. In order for pump contaminates to enter the region of the plasma, they must migrate against the pressure gradient of the differential pumping, $< 10^{-5}$ torr compared to 1 torr. This is highly unlikely. Furthermore, a turbo pump was used which does not have pump oil, and no impurities attributed to pumps were observed in any control spectrum in the 5-560 nm region.

The elimination of known explanations indicate a new result. Since the novel peaks were only observed with helium and hydrogen present, new hydrogen, helium, or helium-hydrogen species are possibilities. It is well known that empirically the excited energy states of atomic hydrogen are given by Rydberg equation (Eq. (2a) for $n > 1$ in Eq. (2b)).

$$E_n = -\frac{e^2}{n^2 8\pi\varepsilon_o a_H} = -\frac{13.598\ eV}{n^2} \tag{2a}$$

$$n = 1,2,3,... \tag{2b}$$

The $n = 1$ state is the "ground" state for "pure" photon transitions (i.e. the $n = 1$ state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy

state may be possible by a resonant nonradiative energy transfer such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common [47]. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling [48].

We propose that atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as He^+ which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2\ eV$ wherein m is an integer. The theory was given previously [49]. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \ldots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \tag{2c}$$

replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. Thus, the Rydberg states are extended to lower levels as depicted in Figure 9. The $n = 1$ state of hydrogen and the $n = \frac{1}{\text{integer}}$ states of hydrogen are nonradiative, but a transition between two nonradiative states is possible via a nonradiative energy transfer, say $n = 1$ to $n = 1/2$. Thus, a catalyst provides a net positive enthalpy of reaction of $m \cdot 27.2\ eV$ (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (2a) and (2c).

The novel peaks fit two empirical relationships. In order of energy, the set comprising the peaks at $91.2\ nm$, $45.6\ nm$, $30.4\ nm$, $13.03\ nm$, $10.13\ nm$, and $8.29\ nm$ correspond to energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,7,9,11$. In order of energy, the set comprising the peaks at $37.4\ nm$, $20.5\ nm$, and $14.15\ nm$ correspond to energies of $q \cdot 13.6 - 21.21\ eV$ where $q = 4,6,8$. These lines can be explained as electronic transitions to fractional Rydberg states of atomic hydrogen given by Eqs. (2a) and (2c) wherein the catalytic system involves helium ions because the second ionization energy of helium is $54.417\ eV$, which is equivalent to $2 \cdot 27.2\ eV$. In this case, $54.417\ eV$ is transferred nonradiatively from atomic hydrogen to He^+ which is resonantly ionized.

The electron decays to the $n = 1/3$ state with the further release of $54.417\ eV$ which may be emitted as a photon. The catalysis reaction is

$$54.417\ eV + He^{+} + H[a_H] \rightarrow He^{2+} + e^{-} + H\left[\frac{a_H}{3}\right] + 108.8\ eV \tag{3}$$

$$He^{2+} + e^{-} \rightarrow He^{+} + 54.417\ eV \tag{4}$$

And, the overall reaction is

$$H[a_H] \rightarrow H\left[\frac{a_H}{3}\right] + 54.4\ eV + 54.4\ eV \tag{5}$$

Since the products of the catalysis reaction have binding energies of $m \cdot 27.2\ eV$, they may further serve as catalysts. Thus, further catalytic transitions may occur: $n = \frac{1}{3} \rightarrow \frac{1}{4}, \frac{1}{4} \rightarrow \frac{1}{5}$, and so on.

Electronic transitions to Rydberg states given by Eqs. (2a) and (2c) catalyzed by the resonant nonradiative transfer of $m \cdot 27.2\ eV$ would give rise to a series of emission lines of energies $q \cdot 13.6\ eV$ where q is an integer. It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. That is, the catalytic reaction

$$H[a_H] \xrightarrow{He^{+}} H\left[\frac{a_H}{3}\right] + 54.4\ eV + 54.4\ eV \tag{6}$$

yields $54.4\ eV$ by Eq. (4) and a photon of $54.4\ eV$ ($22.8\ nm$). Once emitted, the photon may be absorbed or scattered. When this photon strikes $He\ (1s^2)$, $21.2\ eV$ may be absorbed in the excitation to $He\ (1s^1 2p^1)$. This leaves a $33.19\ eV$ ($37.4\ nm$) photon peak and a $21.21\ eV$ ($58.4\ nm$) photon from $He\ (1s^1 2p^1)$. Thus, for helium the inelastic scattered peak of $54.4\ eV$ photons from Eq. (3) is given by

$$E = 54.4\ eV - 21.21\ eV = 33.19\ eV\ (37.4\ nm) \tag{7}$$

A novel peak shown in Figures 2-4 was observed at $37.4\ nm$. Furthermore, the intensity of the $58.4\ nm$ peak corresponding to the spectra shown in Figure 4 was about 60,000 photons/sec. Thus, the transition $He\ (1s^2) \rightarrow He\ (1s^1 2p^1)$ dominated the inelastic scattering of EUV peaks. The general reaction is

$$photon\ (h\nu) + He\ (1s^2) \rightarrow He\ (1s^1 2p^1) + photon\ (h\nu - 21.21\ eV) \tag{8}$$

The two empirical series may be combined—one directly from Eqs. (2a, 2c) and the other indirectly with Eq. (8). The energies for the novel lines in order of energy are $13.6\ eV$, $27.2\ eV$, $40.8\ eV$, $54.4\ eV$, $81.6\ eV$, $95.2\ eV$, $108.8\ eV$, $122.4\ eV$ and $149.6\ eV$. The corresponding peaks are $91.2\ nm$, $45.6\ nm$, $30.4\ nm$, $37.4\ nm$, $20.5\ nm$, $13.03\ nm$, $14.15\ nm$, $10.13\ nm$, and $8.29\ nm$, respectively. Thus, the identified novel lines correspond to energies of $q \cdot 13.6\ eV$, $q = 1,2,3,7,9,11$. or $q \cdot 13.6\ eV$, $q = 4,6,8$ less $21.2\ eV$ corresponding to inelastic scattering of these

photons by helium atoms due to excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. The values of q observed are consistent with those expected based on Eq. (5) and the subsequent autocatalyzed reactions as discussed previously [50]. The broad satellite peak at $44.2\ nm$ show in Figure 2-4 is consistent with the reaction mechanism of a nonradiative transfer to a catalyst followed by emission. There is remarkable agreement between the data and the proposed transitions to fractional Rydberg states and these lines inelastically scattered by helium according to Eq. (8). All other peaks could be assigned to He I, He II, second order lines, or atomic or molecular hydrogen emission. No known lines of helium or hydrogen explain the $q \cdot 13.6\ eV$ related set of peaks.

The Examiner cites Applicant's paper, 28. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, (2002), Vol. 27, No. 3, pp. 301-322, as failing to identify the 304 Å line as the He II line. The Examiner shows carelessness and has erred since Applicant has assigned the 304 Å to He II. Table 1 of gives:

304	304	$He^+(n=2) \rightarrow He^+(n=1) + 40.8\ eV$ [b]	7, 8, 9, 10, 12

In the legend appears:

[b] In Figures 7, 8, 9, 10, and 12, the peak corresponding to $He^+(n=3) \rightarrow He^+(n=1) + 48.35\ eV$ (256 Å)was absent which makes this assignment difficult.

Furthermore, in Sec. IIIA appears:

It is also proposed that the 304 Å peak shown in Figures 7, 8, 9, 10 and 12 was not entirely due to the He II transition. Conspicuously absent was the $256\ \AA$ ($48.3\ eV$) line of He II shown in Figures 6 and 8 which implies only a minor He II transition contribution to the 304 Å peak.

The solar spectrum is not the same as the spectrum of a pure helium-hydrogen (98/2%) plasma. The Sun is known to contain the elements even beyond iron (See Table 4.2 of Stix, M., The Sun, Springer-Verlag, Berlin, (1991)). The Examiner fails to get the point that the elements in the controlled spectrum in the laboratory were not the same as the spectrum recorded on the Sun. In the former case, the gas composition was known precisely and controls were run to identify all positive alternative assignments of the emission.

Section 36

Examiner Souw then incorrectly states on page 4 of the Appendix:

> In this regard, Applicant's change of argument to *"the observed 304 Å line is not entirely due to ionized helium"* is also unpersuasive because: (1) There is no other element known in the art that may have contributed to the 304 Åline; and (2) It does not remove the fact that Applicant has misidentified the 304 Å line as being due to "hydrino".

Using the proper scientific method, the 304 Å line can not be assigned to He II alone as shown in Section 35 above.

Section 37

Examiner Souw further argues on page 4 of the Appendix:

> (B.2) Pg.30
>
> Again, the Examiner is not required to provide alternative explanation; it is sufficient to prove that Applicant's explanation is incredible (see A. 1 above). Since the invention unambiguously claims the effect as being solely due to hydrino, and this hydrino is evidently non-existent, a rejection under 35 U.S.C. § 101 combined with § 112/¶.1 is proper.

This overly simplistic analysis is ripe with errors. As explained below, the Examiner fatally errs in assuming that Applicant's invention is *per se* incredible, without

properly considering the scientific experimental evidence of record. The Committee magnifies this error through its twisted logic that there is no amount of evidence Applicant can submit to prove the existence of lower-energy hydrogen due to its supposed "incredibility," as discussed above in the main response. Application of the scientific method demonstrates that hydrino does exist based on direct spectroscopic measurement and measurement of at least 11 conjugate parameters.

Results include confirmation by at least 11 different techniques that are all showing different aspects of the same thing: a powerful reaction of atomic hydrogen and the formation of hydrino. These include (1) a match between the catalysts and the observed emission for the hydrino reaction, (2) signatures of energetic reactions including extraordinarily hot hydrogen atoms, the predicted formation of plasma, and energetic pumping (excitation) of hydrogen states, (3) large heat of the formation of hydrino, (4) the spectral emission of lower-energy hydrogen atoms, (5) the spectral emission from vibration and rotation of the hydrino molecule, (6) the observation of the corresponding hydrino hydride ion by emission spectroscopy that can not be assigned to any known species, (7) the predicted NMR signature from the hydride ion and the corresponding gas molecule, (8) the binding energy of the molecule and the hydride ion measured by mass spectroscopy and X-ray photoelectron spectroscopy, respectively, (9) the rotational emission of the molecules trapped in the hydride compounds with electron-beam excitation, (10) the isolation and characterization of chemical compounds containing the new hydrides ions that show extraordinary properties and analytical signatures, and most significantly, (11) the exact spectrum predicted for the single-rotational transition of hydrino molecules trapped in the solid compounds. The energies, intensities, line widths, and peak spacing match theory identically, and the results match the body of other evidence from independent techniques. A summary is given in the section entitled "Lower-Energy Hydrogen Experimental Data".

See Applicant's papers such as:

111. R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of

Atomic Hydrogen to Novel Hydrogen Species $H^-(1/4)$ and $H_2(1/4)$ as a New Power Source", Thermochimica Acta, submitted.

ABSTRACT

The data from a broad spectrum of investigational techniques strongly and consistently indicates that hydrogen can exist in lower-energy states then previously thought possible. The predicted reaction involves a resonant, nonradiative energy transfer from otherwise stable atomic hydrogen to a catalyst capable of accepting the energy. The product is $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n=\frac{1}{2},\frac{1}{3},\frac{1}{4},\ldots,\frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. He^+, Ar^+, and K are predicted to serve as catalysts since they meet the catalyst criterion—a chemical or physical process with an enthalpy change equal to an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. Specific predictions based on closed-form equations for energy levels were tested. For example, two $H(1/p)$ may react to form $H_2(1/p)$ that have vibrational and rotational energies that are p^2 times those of H_2 comprising uncatalyzed atomic hydrogen. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$.

The predicted products of alkali catalyst K are $H^-(1/4)$ which form $KH*X$, a novel alkali halido (X) hydride compound, and $H_2(1/4)$ which may be trapped in the crystal. The ^1H MAS NMR spectrum of novel compound $KH*Cl$ relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 ppm corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $H^-(1/p)$ with p = 4. The predicted frequencies of ortho and para-$H_2(1/4)$ were observed at 1943 cm^{-1} and 2012 cm^{-1} in the high resolution FTIR spectrum of $KH*I$ having a -4.6 ppm NMR peak assigned to $H^-(1/4)$. The 1943/2012 cm^{-1}-intensity ratio matched the characteristic ortho-to-para-peak-intensity ratio of 3:1, and the ortho-para splitting of 69 cm^{-1} matched that predicted. $KH*Cl$ having $H^-(1/4)$ by NMR was incident to the 12.5 keV electron-beam which excited similar emission of interstitial $H_2(1/4)$ as observed in the argon-hydrogen plasma. KNO_3 and Raney

> nickel were used as a source of K catalyst and atomic hydrogen, respectively, to produce the corresponding exothermic reaction. The energy balance was $\Delta H = -17{,}925\ kcal/mole\ KNO_3$, about 300 times that expected for the most energetic known chemistry of KNO_3, and $-3585\ kcal/mole\ H_2$, over 60 times the hypothetical maximum enthalpy of $-57.8\ kcal/mole\ H_2$ due to combustion of hydrogen with atmospheric oxygen, assuming the maximum possible H_2 inventory. The reduction of KNO_3 to water, potassium metal, and NH_3 calculated from the heats of formation only releases $-14.2\ kcal/mole\ H_2$ which can not account for the observed heat; nor can hydrogen combustion. But, the results are consistent with the formation of $H^-(1/4)$ and $H_2(1/4)$ having enthalpies of formation of over 100 times that of combustion.

The fact that the Examiner can not find an alternative explanation for all these results is due to scientific fact that there is no alternative explanation.

<u>Section 38</u>

On pages 4-5 of the Souw Appendix, the Examiner again raises nonsensical arguments:

> (B.3) Pg.33-35
>
> (a) Strong bonding must be evidenced by measurement of material hardness [5], not by mere arguments of anomalies observed in XPS spectral lines. Anomalies may have many other causes, but not by hydrino. The latter must be excluded, for having neither experimental nor theoretical justification.

The Examiner's position is completely bases. XPS can identify all elements and give information about their oxidation state by directly measuring the binding energy of each electron. These energies are characteristic of and identify each element. The measurement of the binding energy of the hydrino hydride ions is a means of direct identification. There are infinite numbers of combinations of materials that can be categorized along an essentially continuous scale of hardness. Applicant is frankly astonished that the Examiner calls to supplant direct characterization with some nebulous hardness measurement. How then would the Examiner identify any given

element in the periodic chart? To understand how those educated in materials characterization identify elements, the Examiner should read, for example, C. D. Wagner, W. M. Riggs, L. E. Davis, J. F. Moulder, G. E. Mulilenberg (Editor), *Handbook of X-ray Photoelectron Spectroscopy*, Perkin-Elmer Corp., Eden Prairie, Minnesota, (1997).

Applicant has measured the predicted binding energy of hydrino hydride using XPS, which is confirmed by other independent analytical techniques as given in:

111. **R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species $H^-(1/4)$ and $H_2(1/4)$ as a New Power Source", Thermochimica Acta, submitted.**

The data from a broad spectrum of investigational techniques strongly and consistently indicates that hydrogen can exist in lower-energy states then previously thought possible. The predicted reaction involves a resonant, nonradiative energy transfer from otherwise stable atomic hydrogen to a catalyst capable of accepting the energy. The product is $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n=\frac{1}{2},\frac{1}{3},\frac{1}{4},...,\frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. He^+, Ar^+, and K are predicted to serve as catalysts since they meet the catalyst criterion—a chemical or physical process with an enthalpy change equal to an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. Specific predictions based on closed-form equations for energy levels were tested. For example, two $H(1/p)$ may react to form $H_2(1/p)$ that have vibrational and rotational energies that are p^2 times those of H_2 comprising uncatalyzed atomic hydrogen. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$.

The predicted products of alkali catalyst K are $H^-(1/4)$ which form $KH*X$, a novel alkali halido (X) hydride compound, and $H_2(1/4)$ which may be trapped in the crystal. The ^1H MAS NMR spectrum of novel compound $KH*Cl$ relative to external tetramethylsilane (TMS) showed a

large distinct upfield resonance at -4.4 ppm corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $H^-(1/p)$ with p = 4. The predicted frequencies of ortho and para-$H_2(1/4)$ were observed at 1943 cm^{-1} and 2012 cm^{-1} in the high resolution FTIR spectrum of $KH*I$ having a -4.6 ppm NMR peak assigned to $H^-(1/4)$. The 1943/2012 cm^{-1}-intensity ratio matched the characteristic ortho-to-para-peak-intensity ratio of 3:1, and the ortho-para splitting of 69 cm^{-1} matched that predicted. $KH*Cl$ having $H^-(1/4)$ by NMR was incident to the 12.5 keV electron-beam which excited similar emission of interstitial $H_2(1/4)$ as observed in the argon-hydrogen plasma. KNO_3 and Raney nickel were used as a source of K catalyst and atomic hydrogen, respectively, to produce the corresponding exothermic reaction. The energy balance was $\Delta H = -17,925\ kcal/mole\ KNO_3$, about 300 times that expected for the most energetic known chemistry of KNO_3, and $-3585\ kcal/mole\ H_2$, over 60 times the hypothetical maximum enthalpy of $-57.8\ kcal/mole\ H_2$ due to combustion of hydrogen with atmospheric oxygen, assuming the maximum possible H_2 inventory. The reduction of KNO_3 to water, potassium metal, and NH_3 calculated from the heats of formation only releases $-14.2\ kcal/mole\ H_2$ which can not account for the observed heat; nor can hydrogen combustion. But, the results are consistent with the formation of $H^-(1/4)$ and $H_2(1/4)$ having enthalpies of formation of over 100 times that of combustion.

110. **R. L. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrides as a New Power Source," Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem. 2005, 50(2).**

Plasmas of certain catalysts such as K^+, Sr^+, and Ar^+ mixed with hydrogen were studied for evidence of a novel energetic reaction. These hydrogen plasmas called resonant transfer- or rt-plasmas were observed to form at low temperatures (e.g. $\approx 10^3\ K$) and an extraordinary low field strengths of about 1-2 V/cm. Time-dependent line broadening of the H Balmer α line was observed corresponding to extraordinarily fast H (25 eV). Intense hydrogen Lyman emission, a stationary inverted Lyman population, excessive afterglow duration, highly energetic hydrogen atoms, characteristic alkali-ion emission due to catalysis, predicted novel spectral lines, and the measurement of a power beyond any conventional chemistry were also observed. Using a number of spectroscopic and analytical techniques, the reaction products were identified as atoms with

energies that are an extension of the Rydberg series to lower states as well as the corresponding molecules and hydride ions. The results show the feasibility of this highly exothermic reaction as a new energy source.

25. **R. Mills, W. Good, A. Voigt, Jinquan Dong, "Minimum Heat of Formation of Potassium Iodo Hydride", Int. J. Hydrogen Energy, Vol. 26, No. 11, Oct., (2001), pp. 1199-1208.**

It was previously reported [R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.] that a novel inorganic hydride compound KHI which comprised a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and potassium iodide. Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, ^1H and ^{39}K nuclear magnetic resonance spectroscopy, Fourier transform infrared spectroscopy, electrospray ionization time of flight mass spectroscopy, liquid chromatography/mass spectroscopy, thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis. We report measurements of heats of formation of KHI by differential scanning calorimetry (DSC). With reactant KI present, potassium metal catalyst and atomic hydrogen were produced by decomposition of KH at an extremely slow rate under a helium atmosphere to increase the amount of atomic hydrogen by slowing the rate of molecular hydrogen formation. Since not all of the starting materials reacted, the observed minimum heats of formation were over -2000 $kJ/mole\,H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\,H_2$.

<u>Section 39</u>

Examiner Souw erroneously asserts on page 5 of his Appendix that:

(b) Applicant's XPS line anomaly has been identified by an independent third party as an impurity line: it <u>disappeared after surface cleaning</u> [3]. This refutation has been recited in the previous Appendix, but failed to be addressed in Applicant's response. Therefore, Applicant's insistence of this line of being a "hydrino" line remains unpersuasive on both experimental and theoretical grounds.

The "cleaning" was ion sputtering to remove contamination due to handling the sample, if any. No contamination was noted by comparing the before and after results. From paper #68:

> <u>ToF-SIMS Characterization</u>
>
> The commercial silicon wafer, HF cleaned silicon wafer, and $\alpha - SiH$ coated nickel foil samples were characterized using Physical Electronics TRIFT ToF-SIMS instrument. The primary ion source was a pulsed $^{69}Ga^{+}$ liquid metal source operated at 15 keV [32-33]. The secondary ions were exacted by a ± 3 keV (according to the mode) voltage. Three electrostatic analyzers (Triple-Focusing-Time-of-Flight) deflect them in order to compensate for the initial energy dispersion of ions of the same mass. The 400 pA dc current was pulsed at a 5 kHz repetition rate with a 7 ns pulse width. The analyzed area was 60μm x 60μm and the mass range was 0-1000 AMU. The total ion dose was $7\ X 10^{11}\ ions/cm^{2}$, ensuring static conditions. Charge compensation was performed with a pulsed electron gun operated at 20 eV electron energy. In order to remove surface contaminants and expose a fresh surface for analysis, the samples were sputter-cleaned for 30 s using a 80μm x 80μm raster, with 600 pA current, resulting in a total ion dose of $10^{15}\ ions/cm^{2}$. Three different regions on each sample of 60μm x 60μm were analyzed. The positive and negative SIMS spectra were acquired. Representative post sputtering data is reported. The ToF-SIMS data were treated using 'cadence' software (Physical Electronics), which calculates the mass calibration from well-defined reference peaks.

The hydride was not removed with sputtering which showed that the sample was in fact hydride. It also confirmed the source of the novel XPS peaks was a hydride film.

XPS and TOF-SIMS can identify all of the known elements in all of the oxidation states known for the particular element. There is no element or oxidation state of an element called "impurity". Since the peaks could not be assigned to any known element in any oxidation state as shown by the survey scan, Figure 12 of paper 61, compared to the XPS data of the known elements and their oxidation states (See Ref. 35 of paper 61-C. D. Wagner, W. M. Riggs, L. E. Davis, J. F. Moulder, G. E. Mulilenberg (Editor), *Handbook of X-ray Photoelectron Spectroscopy*, Perkin-Elmer Corp., Eden Prairie, Minnesota, (1997), it must be to an <u>element with a new binding energy</u>. The coating is hydride as shown by TOF-SIMS that is orders of magnitude more stable than ordinary

hydride as shown by TOF-SIMS and XPS, and the XPS peaks matched those predicted for hydrino hydride. Thus, the assignment to lower-energy hydrogen is well supported by the data; whereas, an alternative assignment is not.

From paper # 61:

The 0-70 eV binding energy region of a nickel foil coated with an $\alpha - SiH$ film and exposed to air for 20 min. before XPS analysis is shown in Figure 21. By comparison of the $\alpha - SiH$ sample to the controls, novel XPS peaks were identified at 11, 43, and 55 eV. These peaks do not correspond to any of the primary elements, silicon, carbon, or oxygen, shown in the survey scan in Figure 12, wherein the peaks of these elements are given by Wagner et al. [35]. Hydrogen is the only element which does not have primary element peaks; thus, it is the only candidate to produce the novel peaks and correspond to the H content of the SiH coatings. These peaks closely matched hydrides formed by the catalytic reaction of He^+ with atomic hydrogen and subsequent reactions to form highly stable silicon hydride products $\alpha - SiH$ that were discussed previously [31].

From paper 45:

The energetic plasma reaction was used to synthesize a potentially commercially important product. Nickel substrates were coated by the reaction product of a low pressure microwave discharge plasma of SiH_4 (2.5%)/He (96.6%)/H_2 (0.9%). The ToF-SIMS identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. XPS identified the H content of the SiH coatings as hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The novel hydride ions are proposed to form by the catalytic reaction of He^+ with atomic hydrogen and subsequent autocatalytic reactions of $H(1/p)$ to form highly stable silicon hydride products $SiH(1/p)$ (p is an integer greater than one in Eqs. (4-5)). The SiH coating was amorphous as indicated by the shape of the $Si\ 2p$ peak and was remarkably stable to air exposure. After a 48 hour exposure to air, essentially no oxygen was observed as evidence by the negligible $O\ 1s$ peak at 531 eV and absence of any SiO_x $Si\ 2p$ peak in the region of 102-104 eV. The highly stable amorphous silicon hydride

coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

Section 40

Examiner Souw further mischaracterizes Applicant's scientific evidence on page 5 of the Appendix:

(c) Pg.36-37

The experiment of Marchese et al. cited by Applicant has proven by hard evidence that the reaction suggested by Applicant is not more efficient than conventional reaction (A. Marchese's **Final Report [1] pg.33, lines 1-2 below Fig.29**).

The Examiner has taken the data on a nozzle design out of context. Marchese et al. independently replicated Applicant's results and were not paid (a standard set by the Examiner (see Section 12 of Applicant's main response):

44. **A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.**

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated. See

i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos,

ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the

same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths,

iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos,

iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species, and

v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.

The energetic hydrogen measured in rt-plasmas taught by Applicant was applied to a nozzle design. The context of the statement is evident: "As shown in Fig. 29b, the measured C* values are on the same order as those of chemical rocket propulsion, which is reasonable for the proof of concept test."

Section 41

Examiner Souw further argues on page 5 of the Appendix:

In addition, EarthTech, which is an independent research company, failed to confirm Applicant's claimed result. EarthTech's effort to replicate Applicant's claim is documented at <http://www.earthtech.org/experiments/blp/prelim.html> [2a], and the negative finding at <http://www.earthtech.org/experiments/mills/mills1.html> [2b]. Based on these two negative results alone among others [2a, 2b], Applicant's arguments on pg.36-37 must be deemed unpersuasive. Consequently,

Applicant's claim of having invented a novel, more efficient chemical process, is deemed incredible.

For reasons stated above, publications from A.J. Marchese relating to "hydrino" are not counted as support, but instead, as a refutation of Applicant's claim, in support of the Examiner's. These include "evidence" nos.16 and 44.

The EarthTech issue and the fact that many top laboratories that were not direct competitors of Applicant replicated the very same experiments are discussed in Section 29 above. The two results cited by the Examiner were not negative, as discussed in Sections 21-22 of Applicant's main response. Marchese replicated many aspect's of Applicant's Invention as stated in his report and discussed in Sections 29 and 40 above. Examiner Souw's refusal to acknowledge these facts is further evidence of his blatent bias against Applicant.

Section 42

Examiner Souw incorrectly argues on pages 6-7 of his Appendix that:

(d) Regarding pg. 137-138 of Applicant's main 161 page Response dated 08/11/2004, that the 0.16 nm line broadening cited by the Examiner Souw is allegedly *"negligible to the >**10 eV hot H** found in Applicant's rt-plasmas"*, and further, on pg. 142 of 161, *"absolutely negligible compared to the **>100 eV hot H** found in rt-plasmas"*, must be dismissed for the following reasons:

(d. 1) The 0.16 nm broadening (equivalent to 3,7 cm^{-1}) is cited by Examiner Souw to be compared with the 0.27 nm broadening measured by Applicant, but not to *"10 eV or 100 eV hot HI"* as alleged by Applicant. This purpose is unambiguously clear in this reproduced passage from the Examiner's Appendix attached to the previous action:

"Secondly, and most importantly, anomalous hydrogen line broadening is not at all an evidence for the existence of hydrino, because it is well known in the art that such a broadening may be caused by many other conventional mechanisms, such as microwave plasm3a effects, the latter having not been considered by Applicant. Instead, such an effect

*has been so far ignored or dismissed by Applicant without any valid reason. The measured excessive line-width shown in Applicant 's Fig. 6 of ref. [6], i.e., **0.27nm**. is about the same magnitude as what is measured by other authors, e.g., ref. [5] cited in the May 7 Appendix, here reproduced in Fig. 1 below.*

As shown in Fig. [1], the anomalous line width of **0.16 nmn**, measured in a microwave discharge similar to Applicant 's under the same gas mixture and pressure range, is about 10 *times the Doppler width, and has been attributed to microwave plasma effects." (ref [5] Luggenhoelscher et al.; Ref [6] Mills et a!.)*

Obviously, Applicant has misrepresented the original dispute over Applicant's 0.27 linewidth by changing or shifting the original subject matter into something else (translational kinetic energy; see below).

Examiner Souw is not only confused, but is not internally consistent even with the views expressed in the same Office Action. As reported in Section 18 of Applicant's main response, the Committee states that

> Applicant has also seriously misinterpreted the Examiner's plasma arguments by incorrectly comparing the Examiner's cited line broadening of 0.16 nm in the prior art with >100 eV hot H found in applicant's rt-plasmas. Due to applicant's misinterpretation of the Examiner's statements, the data of the prior art and his own data, he incorrectly states that the line broadening observed in Luggenhoelscher is off by six orders of magnitude as compared to applicant's observed line widths on page 169 of the present response. The applicant's misinterpretation of the Examiner's remarks on his plasma data, those of the cited prior art, and his own data are detailed on pages 6-12 of the attached appendix (Part I, section B (subsections d.1-d.6, e, and f)).

This is in direct contradiction to the position espoused in a previous Office Action, wherein the opposite is stated:

> Applicant points out that the reasons for Balmer line broadening are discussed in many articles, and that the observed broadening is in excess in what can be expected from known sources thereof. This is not persuasive because broadening may be caused by various means including those taken into account by applicant, and those not taken into account. In the enclosed article by Luggenholscher, et. al. , broadening equivalent to that found by applicant, shown in figure 1, is accounted for by conventionally known explanations such as the Stark effect. The enclosed article by Luque et. al. accounts for Halpha

broadening using two Lorentzian mechanisms (Stark and Van der Waals) and two Gaussian mechanisms (Doppler and instrumental).

Then in this section, the Examiner returns to the Committee's original position even in light of the strongly emphasized paper of Jovicevic et al. In S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004), the authors state that it was impossible to measure any microwave field effect or Stark effect and it would require a resolution of better than about 0.02 nm (See P. 28 line 14).

The broadening reported in the Examiner's reference URL: http://www.phys.tue.nl/FLTPD/Luggenhoelscher.pdf is 0.37 cm-1 with no field and 3.7 cm-1 with the application of the microwave field. The energies corresponding to these widths are $4.5\ X10^{-5}\ eV$ and $4.5\ X10^{-4}\ eV$, respectively, which is absolutely negligible compared to the >10 eV hot H found in rt-plasmas. The microwave field can not explain Applicant's results. The Examiner's alternative explanation is off by six orders of magnitude.

The Examiner is grossly in error of the relative difference between the results in Applicant's paper #49 and those of the Examiner's Luque et al. paper. The broadening reported in the Examiner's reference URL: http://www.phys.tue.nl/FLTPD/Luggenhoelscher.pdf is 0.37 cm-1 with no field and 3.7 cm-1 with the application of the microwave field. The energies corresponding to these widths are $4.5\ X10^{-5}\ eV$ and $4.5\ X10^{-4}\ eV$, respectively, which is absolutely negligible compared to the >10 eV hot H found in rt-plasmas. The microwave field can not explain Applicant's results. The microwave field can not explain Applicant's results of extraordinary broadening observed in these cells with catalysts present and not observed under identical conditions with no catalyst present.

The Examiner should take better care to read the units of Fig. [1] that are in cm-1, **NOT nm**. The difference is about **SIX ORDERS MAGNITUDE in H energy**.

The Examiner exhibits the same pattern of internal inconsistency with his argument of the basis of SQM. SQM is not a theory based on physical laws as stated

by the Examiner. It has nothing to do with physics. It is purely mathematical and relies on metaphysical beliefs that reality is created by measurement, that virtual particles exist in every point in space, that extra compactified dimensions exist that can not be observed, that spooky actions at distance are the norm, that infinities exist, but can be renormalized, etc. This is the truth of the Examiner's position that he falsely and unfairly projects onto Applicant when Applicant has rigorously derived his results from Maxwell's' equations, Newton's laws and special relativity. As is common practice by quantum aficionados, the Examiner grossly distorts and hypes the capabilities of SQM. Applicant's results are closed-form equations with fundamental constants only. The results are predictive in that the solution for any given parameter is predictive of the conjugate parameters. There is not an single example in SQM where this is the case. Furthermore, if SQM were required to adhere to physical laws and internal consistency, there is not even a single example of a successful prediction.

Section 43

On page 7 of the Souw Appendix, the Examiner presents yet another nonsensical argument:

> (d.2) By reciting 10 eV on pg. 138, but 100 eV on pg.142, not only has Applicant compared to a differently related quantity (presumed translational kinetic energy; see next), but also has Applicant failed to particularly point out the subject matter he wants to raise (10 eV or 100 eV?).

The Examiner is obviously confused. Doppler broadening is due to kinetic energy as given in Applicant's papers, the papers cited by the Examiner:

> S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004).
> N. Cvetanovic, M. M. Kuraica and N. Konjevic, J. Appl. Phys. 97, 33302 (2005).

and many others:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", Physical Review A, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", Spectrochimica Acta, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer-α in dense plasmas", Phys, Rev. E, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", J. Appl. Phys., Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", Appl. Phys. Lett., Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha (H_α) excitation in $Ar-H_2$ radio-frequency discharges", J. Appl. Phys., Vol. 78, No. 2, (1995), pp. 746-757.
8. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
9. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.
10. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
11. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
12. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
13. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain

Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
14. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
15. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
16. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
17. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.

Section 44

Examiner Souw continues his misguided arguments on page 7 of the Appendix, stating that:

> (d.3) Applicant is silent about writing the 3.7 cm^{-1} linewidth in wavelength unit. The alternative expression, $\delta\lambda$= 0.16 nm, obviates Applicant's $\delta\lambda$=0.27 nm, without ever postulating or presuming any Doppler effect. Instead, Applicant chose to express the observed line width in [eV] unit, which is simply obtained by multiplying the linewidth originally in units of wavenumber (3.7 cm^{-1}) with c=3·0^{10} cm/sec, thus resulting in $\delta\lambda$ 100 GHz, and further multiplying with the Planck constant h=4x10^{-15} eV?sec to give approximately h?äí?0.45 meV. While the expression hí bears the physical meaning of a kinetic energy of an oscillating electron having a frequency í, the new quantity h?äí would mean a blur or spread in the oscillation kinetic energy of a radiating electron transition dipole, the latter being a QM entity without classical correspondence (=<$ø_2$??|**a·D** |$ø_1$>; see original Appendix, sect.3/pg.7). This blur may be due to Stark effect or microwave effect or something else that does not need to be further specified at this point. However, Applicant proceeds to improperly compare this line width with a hypothetical 10-100 eV translational kinetic energy, which is not just in a different unit, but of a totally different nature involving a sequence of presumptions that is not only controversial, but also disputable, as will be described next. Thus, Applicant is comparing "apples" to "oranges".

Again, the Examiner is deeply confused. The standard unit for reporting line broadening in the plasmas of interest in this case are electron volts (eV). See the following papers including those cited by the Examiner:

S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004).
N. Cvetanovic, M. M. Kuraica and N. Konjevic, J. Appl. Phys. 97, 33302 (2005).

and many others:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", Physical Review A, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", Spectrochimica Acta, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer-α in dense plasmas", Phys, Rev. E, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", J. Appl. Phys., Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", Appl. Phys. Lett., Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha (H_α) excitation in $Ar - H_2$ radio-frequency discharges", J. Appl. Phys., Vol. 78, No. 2, (1995), pp. 746-757.
8. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
9. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.

10. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
11. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
12. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
13. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
14. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
15. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
16. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
17. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.

The Examiner is also grossly in error of the relative difference between the results in Applicant's paper #49 and those of the Examiner's Luque et al. paper. The broadening reported in the Examiner's reference URL: http://www.phys.tue.nl/FLTPD/Luggenhoelscher.pdf is 0.37 cm-1 with no field and 3.7 cm-1 with the application of the microwave field. The energies corresponding to these widths are $4.5\ X10^{-5}\ eV$ and $4.5\ X10^{-4}\ eV$, respectively, which is absolutely negligible compared to the >10 eV hot H found in rt-plasmas. The microwave field can not explain Applicant's results. The microwave field can not explain Applicant's results of

extraordinary broadening observed in these cells with catalysts present and not observed under identical conditions with no catalyst present.

The Examiner should take better care to read the units of Fig. [1] that are in cm-1, **NOT nm**. The difference is about **SIX ORDERS MAGNITUDE in H energy**.

Specially, the width reported in energy is 3.7 cm-1 corresponding to 4.5 meV. The method to calculate the energetic hydrogen atom energies from the width of the 656.3 nm Balmer α line is given by Videnovic et al. [3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", Spectrochimica Acta, Part B, Vol. 51, (1996), pp. 1707-1731]. The full half-width $\Delta\lambda_G$ of each Gaussian results from the Doppler ($\Delta\lambda_D$) and instrumental ($\Delta\lambda_I$) half-widths:

$$\Delta\lambda_G = \sqrt{\Delta\lambda_D^2 + \Delta\lambda_I^2} \tag{1}$$

$\Delta\lambda_I$ for these experiments was 0.05 nm. The temperature was calculated from the Doppler half-width using the formula:

$$\Delta\lambda_D = 7.16\, X\, 10^{-7}\lambda_0\left(\frac{T}{\mu}\right)^{1/2} \tag{2}$$

where λ_0 is the line wavelength, T is the temperature in K ($1\ eV = 11,605\ K$), and μ is the molecular weight (=1 for hydrogen).

Thus, the line width in nm corresponding to an energy of 3.7 cm-1 (4.5 meV) is given by

$$\Delta\lambda_D = 7.16\, X\, 10^{-7}(656nm)\left(\frac{4.5X10^{-3}(11,605K/eV)}{1}\right)^{1/2} \tag{3}$$

$$0.001\ nm$$

which is absolutely trivial.

The carelessness of the Examiner and the fact that he is waffling is shown in Section 42 above. This is obvious given that the Examiner went from arguing no broadening then to his original position of broadening with a trivial explanation of

microwave field broadening even in light of the strongly emphasized paper of Jovicevic et al. In S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004), the authors state that it was impossible to measure any microwave field effect or Stark effect and it would require a resolution of better than about 0.02 nm (See P. 28 line 14). Even more disturbing is that the Examiner has based a major portion of his rejection of a subject matter over which he is obviously confused to the point that he fails to distinguish between units of energy versus units of wavelength.

The broadening is unequivocally Doppler broadening as discussed in References #49 and # 37. The microwave-field broadening cited in Examiner's Luque et al paper is six orders of magnitude too low to account for the broadening reported by Applicant (e.g. Ref. #49). In fact, the point of the paper by Luque et al. was the very technically difficult Doppler-free two-photon excitation to show the microwave effect which can not otherwise be observed since it is overwhelmed by the Doppler broadening as also pointed out in the strongly emphasized paper of Jovicevic et al (S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004)).

In addition, the magnitude of the broadening varies as expected based on the particular catalyst and the duration of the reaction with more energetic transitions occurring with time as discussed in

51. **J. Phillips, C-K Chen, R. Mills, "Evidence of catalytic Production of Hot Hydrogen in RF Generated Hydrogen/Argon Plasmas", IEEE Transactions on Plasma Science, submitted.**

    J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies of line broadening in catalysis plasmas. This is the third in a series of papers by our team on apparently anomalous Balmer series line broadening in hydrogen containing RF generated, low pressure (< 600 mTorr) plasmas. In this paper the selective broadening of the atomic hydrogen lines in pure H2 and Ar/H2 mixtures in a large "GEC" cell (36 cm length X 14 cm ID) was mapped as a function of position, H2/Ar ratio, time, power, and pressure. Several observations regarding the selective line broadening were particularly notable as they are

unanticipated on the basis of earlier models. First, the anomalous broadening of the Balmer lines was found to exist throughout the plasma, and not just in the region between the electrodes. Second, the broadening was consistently a complex function of the operating parameters particularly gas composition (highest in pure H2) position, power and pressure. Clearly not anticipated by earlier models were the findings that under some conditions the highest concentration of "hot" (>10 eV) hydrogen was found at the entry end, and not in the high field region between the electrodes and that in other conditions, the hottest H was at the (exit) pump (also grounded electrode) end. Third, excitation and electron temperatures were less than one eV in all regions of the plasma not directly adjacent (>1mm) to the electrodes, providing additional evidence that the energy for broadening, contrary to standard models, is not obtained from the field. Fourth, in contrast to our earlier studies of hydrogen/helium and water plasmas, we found that in some conditions 98% of the atomic hydrogen was in the "hot" state throughout the GEC cell. Virtually every operating parameter studied impacted the character of the hot H atom population, and clearly second and third order effects exist, indicating a need for experimental design. Some non-field mechanisms for generating hot hydrogen atoms, specifically those suggested by Mills' CQM model, are outlined.

Section 45

Examiner Souw commits further errors in his analysis on page 8 of the Appendix:

(d.4) Applicant (mis)interpret the observed linewidth as a Doppler width, for which there is no justification, but --at most-- only a presumption or tentative suggestion. To recapitulate, Applicant came to the 10-100 eV number by firstly presuming the observed linewidth as being entirely due to Doppler effect. Secondly, Applicant then converts the frequency shift (100 GHz) corresponding to the observed line broadening into atomic velocity, then finally multiplying the square of this velocity by the atomic mass to derive the suggested 10-100 eV translational kinetic energy (which is totally of different nature than the 0.45 meV blur or spread of unknown origin in the oscillation kinetic energy of a radiating electron transition dipole, as recited above). Such a derivation is based on a sequence of presumptions that may be partially or even entirely incorrect. Although Doppler effect is omnipresent, there is no justification for assuming the observed line broadening as being entirely due to the Doppler effect. The factual evidence only shows a 0.16 nm line width as observed by Luggenhoelscher, comparable to a 0.27 nm claimed by Applicant. There is no evidence that Applicant's 0.27 nm can be

correlated to a translational kinetic energy of">l0 eV" or ">100 eV", or whatsoever, by presuming the linewidth were entirely caused by ***"hot H"***, as postulated by Applicant.

The broadening is unequivocally Doppler broadening as stated in the Examiner's' cited paper, N. Cvetanovic, M. M. Kuraica and N. Konjevic, J. Appl. Phys. 97, 33302 (2005), as well as those given in Section 43 above. The Examiner is oblivious to the body of evidence that he even cites that identifies the observations of line broadening as due to hot H with energies in the range of 10-300 eV.

The Examiner cites Applicant's paper:

49. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 3, (2003), pp. 338-355.

The introduction is copied below to help educate the Examiner on the proper background in this field on which he so heavily relies for his rejections:

I. INTRODUCTION

Glow discharge devices have been developed over decades as light sources, ionization sources for mass spectroscopy, excitation sources for optical spectroscopy, and sources of ions for surface etching and chemistry [1-3]. A Grimm-type glow discharge is a well established excitation source for the analysis of conducting solid samples by optical emission spectroscopy [4-6]. But, only in the last decade has extensive spectroscopic characterization been conducted that has led to some puzzling observations. For example, M. Kuraica and N. Konjevic [7], Videnovic et al. [8], and others [9-12] have characterized mixed hydrogen-argon plasmas by determining the excited hydrogen atom energies from measurements of the line broadening of one or more of the Balmer α, β, and γ lines of atomic hydrogen at 656.28, 486.13, and 434.05 nm, respectively. They found that the Balmer lines were extremely broadened and explained the phenomenon primarily in terms of Doppler broadening due to the acceleration of charges such as H^+, H_2^+, and H_3^+ in the high fields (e. g. over $10\ kV/cm$) present in the cathode fall region.

Djurovic and Roberts [10] recorded the spectral and spatial profiles of Balmer α line emission from low pressure RF (13.56 MHz) discharges in $H_2 + Ar$ mixtures in a direction normal to the electric field. The introduction of Ar in a pure H_2 plasma increased the number of fast neutral atoms as evidenced by the intensity of the broad component of a two-component Doppler-broadened Balmer α line profile. Independent of cell position or direction, the average energy of a wide profile component was 23.8 eV for voltages above 100 V, and the average energy of a slow component was 0.22 eV. The mechanism proposed by Djurovic and Roberts is the production of fast H atoms from electric field accelerated H_2^+. The explanation of the role of Ar in the production of a large number of excited hydrogen atoms in the $n = 3$ state, as well as raising their energy for a given pressure and applied RF voltage, is that collisions with Ar in the plasma sheath region enhances the production of fast H_2 from accelerated H_2^+. The fast H_2 then undergoes dissociation to form fast H which may then be excited locally to the $n = 3$ state by a further collision with Ar. The local excitation is a requirement since the atomic lifetime of the hydrogen $n = 3$ state is approximately 10^{-8} s, and the average velocity of the hydrogen atoms is $< 10^5$ m/s. Thus, the distance traveled must be less that 0.001 m. A number of additional mechanisms have been proposed in order to explain the excessive Doppler broadening of the Balmer α line in argon-hydrogen DC or RF driven glow discharge plasmas all of which ultimately depend on electric field acceleration of hydrogen positive ions.

Hydrogen mixed with certain noble gases has also been observed to give unexpected hydrogen emission intensity. For example, based on its unusually intense emission, a neon-hydrogen microhollow cathode glow discharge has been proposed as a source of predominantly Lyman α radiation. Kurunczi, Shah, and Becker [13] observed intense emission of Lyman α and Lyman β radiation at 121.6 nm and 102.5 nm, respectively, from microhollow cathode discharges in high-pressure Ne (740 Torr) with the addition of a small amount of hydrogen (up to 3 Torr). With essentially no molecular emission observed, Kurunczi et al. attributed the anomalous Lyman α emission to the near-resonant energy transfer between the Ne_2^* excimer and H_2 which leads to formation of $H(n = 2)$ atoms, and attributed the Lyman β emission to the near-resonant energy transfer between excited Ne^* atoms (or vibrationally excited neon excimer molecules) and H_2 which leads to formation of $H(n = 3)$ atoms. Despite the emission characterization of this source, data is lacking about plasma parameters.

A new low-electric field plasma source has been developed that is based on a resonant energy transfer of an integer of $27.2\ eV$ from atomic hydrogen to a catalyst capable of accepting the energy. It operates by incandescently heating a hydrogen dissociator and a catalyst to provide atomic hydrogen and gaseous catalyst, respectively, such that the catalyst reacts with the atomic hydrogen to produce a plasma called a resonant transfer (rt)-plasma. It was extraordinary, that intense vacuum ultraviolet (VUV) emission was observed [14-16] at low temperatures (e.g. $\approx 10^3\ K$) from atomic hydrogen and certain atomized elements or certain gaseous ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $27.2\ eV$ that comprise catalysts. The only pure elements that were observed to emit VUV were those wherein the ionization of t electrons from an atom to a continuum energy level is such that the sum of the ionization energies of the t electrons is approximately $m \cdot 27.2\ eV$ where t and m are each an integer. For example, K, Cs, Sr, Sr^+, and Rb^+ each ionize at integer multiples of the potential energy of atomic hydrogen and caused emission as predicted; whereas, the chemically similar atoms, Na, Mg, and Ba, do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission as predicted as well. The theory and balanced resonant energy transfer reactions have been given previously [14-15, 17] or are in press [16, 18].

In addition, Ar^+ and He^+ each ionize at an integer multiple of the potential energy of atomic hydrogen; thus, a discharge with one or more of Sr^+, Ar^+, and He^+ present with hydrogen was anticipated to form an rt-plasma. Mills and Nansteel [14] have reported that rt-plasmas formed with Sr^+ and Ar^+ catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input of up to 8600 times that of control standard light sources. Characteristic emission was observed from a continuum state of Ar^{2+} which confirmed the resonant nonradiative energy transfer of $27.2\ eV$ from atomic hydrogen Ar^+ [19]. Predicted emission lines were observed from helium-hydrogen [17-18, 20] as well as strontium-argon-hydrogen plasmas [19] that supported the rt-plasma mechanism.

He^+ ionizes at $54.417\ eV$ which is $2 \cdot 27.2\ eV$, and novel VUV emission lines were observed from microwave and glow discharges of helium with 2% hydrogen [20]. The observed energies were $q \cdot 13.6\ eV$ ($q = 1,2,3,4,6,7,8,9,\ or\ 11$) or these discrete energies less $21.2\ eV$ corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He\,(1s^2)$ to $He\,(1s^1 2p^1)$. These lines can be explained by the resonant transfer of 2 times $27.2\ eV$, with He^+ to He^{2+} [20].

It was anticipated that glow, microwave, and RF discharges could each also provide atomic hydrogen and a catalyst to form an rt-plasma. In the present paper, we report studies to further characterize the plasma parameters observed in such rt-plasmas as well as the difference between rt-plasmas created by glow, microwave, and inductively and capacitively coupled RF discharge sources. The line broadening and intensity of the 656.3 nm Balmer α line was measured to determine the excited hydrogen atom energy and the H concentration in plasmas of hydrogen with a catalyst as well as plasmas comprising hydrogen with chemically similar controls that did not provide gaseous atoms or ions having electron ionization energies which are a multiple of $27.2\ eV$. In addition, the electron temperature T_e was measured on microwave and inductively coupled RF plasmas using the ratio of the intensity I of two visible noble gas lines in two quantum states that were close in wavelength such as the ratio $I(He\ 501.6\ nm\ line)/I(He\ 492.2\ nm\ line)$ and the ratio $I(Ar\ 377.03\ nm\ line)/I(Ar\ 420.06\ nm\ line)$ for plasmas having helium and argon, respectively, alone or as a mixture with hydrogen.

We report here, that anomalous line broadening of H_α was observed as predicted in specific rt-plasmas gas mixtures but not in others where the resonant transfer condition was not satisfied. Moreover, as discussed *supra*, a number of mechanisms have been proposed in order to explain the excessive Doppler broadening of the Balmer α line in argon-hydrogen high voltage DC or RF driven glow discharge plasmas that are all ultimately based on acceleration in a high electric field. We show that the experimental evidence from several rt-plasma sources does not support such a mechanism. These are shown to be untenable based on additional data and based on our results with microwave plasmas where no strong applied electric field (e. g. over $10\ kV/cm$) or cathode fall region is present. Moreover, we anticipate the observed results based on the rt-plasma mechanism.

Section 46

Examiner Souw's erroneous analysis continues with the following arguments on pages 8-9 of his Appendix:

Thus, a correlation of the observed line broadening anomaly with hydrogen translational kinetic energy, or velocity, or Doppler effect, is NOT a FACT, but only a suggestion or preposition, as correctly stated by Kovacevic et a!. [6] by using the wording "probably" and "possible process", seeing that there are still other mechanisms also probable. As a matter of fact, the plasma sheath effect proposed by Kovacevic et al. in [6]

sounds even much more plausible than Applicant's postulated hydrino. While it is not the job of the PTO to participate in a scientific debate, a plausibility consideration is here appropriate. Kovacevic's plasma sheath is more plausible, simply because plasma sheath is a well known fact **[7]** routinely observed by many other researchers in a large number of unrelated phenomena, as opposed to "hydrino", whose existence is unproven by any evidence, and even more, in violation of known laws of physics, while also being postulated under an incredibly large number of mathematical flaws and conceptual misunderstanding.

Again, the Examiner is obviously confused. The broadening is unequivocally Doppler as cited by many references in addition to those of Applicant. See:

S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004).
N. Cvetanovic, M. M. Kuraica and N. Konjevic, J. Appl. Phys. 97, 33302 (2005).

and many others:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", Physical Review A, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", Spectrochimica Acta, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer-α in dense plasmas", Phys, Rev. E, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", J. Appl. Phys., Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", Appl. Phys. Lett., Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-

energy distributions and Balmer-alpha (H_α) excitation in $Ar-H_2$ radio-frequency discharges", J. Appl. Phys., Vol. 78, No. 2, (1995), pp. 746-757.

8. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
9. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.
10. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
11. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
12. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
13. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
14. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
15. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
16. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
17. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.

Doppler broadening is due to kinetic energy as stated in those papers. What is argued by others is that the origin of the broadening is electric-field acceleration. Applicant has shown that this can not be the explanation since among other observations, the line broadening is found undiminished in regions of the cell where there is no measured electric field, the effect is independent of direction of observation with respect to the field, it is time dependent, is selective for H, only occurs in cells having Applicant's predicted catalysts to form hydrino, and occurs in cells with no or very low fields such as microwave plasmas and filament (rt-plasma) cells. These points and the supporting references appear in Section 19 of Applicant's main response and others above.

Furthermore, SQM violates physical laws; whereas, CQM is derived from those laws as pointed out below. The existence of hydrino is confirmed overwhelming by the experimental evidence, such as that summarized in Section 2 of Applicant's main response and in Section 28 above.

Section 47

Examiner Souw further argues without merit on page 9 of the Appendix:

> Thus, while 0.16 nm and 0.27 nm are scientific facts, Applicant's "10 eV or 100 eV **hot H**" is ***not*** a scientific ***fact***, since the relation to translational kinetic velocity or energy (Doppler effect) of the radiating atom is only presumed without valid evidence (see Kovacevic [6]). Valid as hard evidence would be, e.g., a Doppler-free laser spectroscopic measurement, such as what was done by the Examiner in previously cited Ref.[8]. This would indisputably separate the Doppler effect from the homogeneous line broadening, the latter including Stark effects and microwave effects. Without such a hard evidence, Applicant's claim of"10 *eV or 100 eV hot H"* remains a hypothesis. Furthermore, such a claim does not have any relevance to, let alone a justification for, the existence of "hydrino". It is thus concluded, Applicant's claim that the observed anomalous hydrogen line broadening were due to "hydrino" remains scientifically *incredible*, justifying the previously applied § 101 and § 112/¶.1 claim rejections.

The broadening is unequivocally Doppler broadening as given in the references cited in Section 46 above. The hydrino explanation is the only one consistent with all of the data, as discussed above in Section 46, for example. For a specific independent analysis, see:

51. **J. Phillips, C-K Chen, R. Mills, "Evidence of catalytic Production of Hot Hydrogen in RF Generated Hydrogen/Argon Plasmas", IEEE Transactions on Plasma Science, submitted.**
J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies of line broadening in catalysis plasmas. This is the third in a series of papers by our team on apparently anomalous Balmer series line broadening in hydrogen containing RF generated, low pressure (< 600 mTorr) plasmas. In this paper the selective broadening of the atomic hydrogen lines in pure H2 and Ar/H2 mixtures in a large "GEC" cell (36 cm length X 14 cm ID) was mapped as a function of position, H2/Ar ratio, time, power, and pressure. Several observations regarding the selective line broadening were particularly notable as they are unanticipated on the basis of earlier models. First, the anomalous broadening of the Balmer lines was found to exist throughout the plasma, and not just in the region between the electrodes. Second, the broadening was consistently a complex function of the operating parameters particularly gas composition (highest in pure H2) position, power and pressure. Clearly not anticipated by earlier models were the findings that under some conditions the highest concentration of "hot" (>10 eV) hydrogen was found at the entry end, and not in the high field region between the electrodes and that in other conditions, the hottest H was at the (exit) pump (also grounded electrode) end. Third, excitation and electron temperatures were less than one eV in all regions of the plasma not directly adjacent (>1mm) to the electrodes, providing additional evidence that the energy for broadening, contrary to standard models, is not obtained from the field. Fourth, in contrast to our earlier studies of hydrogen/helium and water plasmas, we found that in some conditions 98% of the atomic hydrogen was in the "hot" state throughout the GEC cell. Virtually every operating parameter studied impacted the character of the hot H atom population, and clearly second and third order effects exist, indicating a need for experimental design. Some non-field mechanisms for generating hot hydrogen atoms, specifically those suggested by Mills' CQM model, are outlined.

The line broadening result is consistent with at least 11 other conjugate parameters measured on Applicant's plasma reactors, as shown in Section 2 of Applicant's main response and in Section 28 above.

Section 48

On pages 9-10 of the Appendix, Examiner Souw further errs in stating that:

(d.5) Applicant's method of estimating the 10-100 eV kinetic energy will now be applied to the Examiner's 0.16 nm linewidth (measured as full width at half maximum, FWHM), showing the sequence of presumptions thereby made, without regards of the validity of Applicant's unverified Doppler presumption. Firstly, the linewidth 3.7 cm^{-1} or 0.16 nm is converted into atomic velocity $\langle v \rangle$ according to the well known Doppler-shift formula äë/ë=v/c, presuming firstly there is no other contributing effects, and secondly, that the homogenous linewidth is negligible. By taking account for a factor originating from the relationship between a presumed Maxwell-Boltzman velocity distribution and the definition of FWHM Doppler linewidth, one easily obtains a 1-dimensional average hydrogen translational linear velocity $\langle v_Z \rangle$. Presuming further that the velocity distribution is isotropic and 3-dimensional, this translational linear velocity corresponds to an average (3-dimensional) translational kinetic energy of $KE=m\langle v^2 \rangle/2$, where m is the mass of atomic hydrogen ($=1.67\cdot10^{-24}$ gm). Ready-to-use formulas that may be taken for the above estimates are, for example, äë/ë=äí/í=(1/c)??(8kT?ln2/m) [9] and $KE=m\langle v^2 \rangle/2=3kT/2$ [10], in terms of the temperature T as a redundant parameter. One of ordinary skill in the art easily obtains a translational kinetic energy of *KE=**15.2 eV**,* which properly corresponds to the 0.16 nm line width under the presumptions described above.

We see, this **15.2 eV** kinetic energy is very much comparable to Applicant's **10-100 eV**, just in the same manner as 0.16 nm is comparable to 0.27 nm. Thus, by writing a directly measured linewidth 3.7 cm^{-1} in an alternative unit, 0.45 meV (which itself does not make sense), and then comparing the latter with a hypothesized 10 eV translational kinetic energy, not only is Applicant making an improper comparison, but Applicant is also violating a conceptual fundament of physics, like comparing "apples" with "oranges".

As shown in Section 44 above, the 3.7 cm-1 corresponds to an energy of 4.5 meV. The Examiner does not calculate the Doppler energy correctly according to the following references:

S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004).
N. Cvetanovic, M. M. Kuraica and N. Konjevic, J. Appl. Phys. 97, 33302 (2005).

and many others:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", Physical Review A, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", Spectrochimica Acta, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer-α in dense plasmas", Phys, Rev. E, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", J. Appl. Phys., Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", Appl. Phys. Lett., Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha (H_α) excitation in $Ar - H_2$ radio-frequency discharges", J. Appl. Phys., Vol. 78, No. 2, (1995), pp. 746-757.
8. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
9. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied

Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.
10. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
11. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
12. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
13. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
14. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
15. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
16. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
17. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.

Section 49

Examiner Souw further argues on pages 10-11 of the Appendix that:

(d.6) Applicant's lengthy discussion on various broadening mechanism conducted on pgs. 139-142 is well known in the art, and is not argued by the Examiner. Disputed is here the interpretation of the observed broadening as being due to atomic velocity, or translational kinetic energy, or Doppler effect. The latter is no more than a probable mechanism, as correctly stated by Kovacevic [6] by using the wording "probably" and "possible process". There are many other possibilities that would also explain the observed effect, e.g., the well known microwave effect

proposed by other researchers, e.g., Luggenhoelscher, as cited previously. <u>Applicant is totally silent about this microwave effects</u>.

These statements are not true. The selective H broadening is unequivocally Doppler broadening as stated by scores of researchers over decades of study. Applicant has discovered the origin of the predicted effect in Applicant's rt-plasma cells as due to the energy released as hydrogen undergoes transitions to lower-energy states.

<u>Section 50</u>

Examiner Souw further asserts without basis on page 11 of his Appendix that:

(e) Applicant's statement on pg.139, lines 1-3, that *"Stark broadening of hydrogen lines can not be measured at low electron densities ...*", is scientifically inaccurate. Stark broadening, or any homogeneous line broadening, such as due to microwave effects, can well be accurately measured (to 10^{-5} nm or even better), e.g., by means of Doppler-free Laser Spectroscopy, as demonstrated by the Examiner in his own work cited previously [8]. Such a measurement would have been scientifically acceptable as hard evidence for the Doppler effect (but not for "hydrino"), since the Doppler-free technique would be able to cancel out the Doppler effect, thereby measuring only the intrinsic/homogeneous broadening (e.g., natural broadening, Stark broadening, both static and dynamic, AC Stark effect, microwave effects, etc.).

These effects are negligible compared to the observed >0.1 nm Gaussian broadening corresponding to the Doppler effect.

From Ref. #49. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355:

> We have assumed that Doppler broadening due to thermal motion was the dominant source to the extent that other sources may be neglected. To justify this assumption, each source is now

considered. In general, the experimental profile is a convolution of a Doppler profile, an instrumental profile, the natural (lifetime) profile, Stark profiles, Van der Waals profiles, a resonance profile, and fine structure. The instrumental half-width is measured to be $\pm 0.006\ nm$. The natural half-width of the Balmer α line given by Djurovic and Roberts [10] is $1.4\ X\, 10^{-4}\ nm$ which is negligible. The fine structure splitting is also negligible.

Stark broadening of hydrogen lines in plasmas can not be measured at low electron densities using conventional emission or absorption spectroscopy because it is hidden by Doppler broadening. In the case of the Lyman α line, the Stark width exceeds the Doppler width only at $n_e > 10^{17}\ cm^{-3}$ for temperatures of about $10^4\ K$ [34]. Gigosos and Cardenoso [35] give the observed Balmer α Stark broadening for plasmas of hydrogen with helium or argon as a function of the electron temperature and density. For example, the Stark broadening of the Balmer α line recorded on a $H + He^{+}$ plasma is only 0.033 nm with $T_e = 20{,}000\ K$ and $n_e = 1.4\ X\, 10^{14}\ cm^{-3}$.

The relationship between the Stark broadening $\Delta\lambda_S$ of the Balmer β line in nm, the electron density n_e in m^{-3}, and the electron temperature T_e in K is

$$\log n_e = C_0 + C_1 \log(\Delta\lambda_S) + C_2[\log(\Delta\lambda_S)]^2 + C_3 \log(T_e) \tag{5}$$

where $C_0 = 22.578$, $C_1 = 1.478$, $C_2 = -0.144$, and $C_3 = 0.1265$ [36]. From Eq. (5), to get a Stark broadening of only 0.1 nm with $T_e = 9000\ K$, an electron density of about $n_e \sim 3\ X\, 10^{15}\ cm^{-3}$ is required, compared to that of the argon-hydrogen plasma of $< 10^9\ cm^{-3}$ determined using a compensated Langmuir probe, over six orders of magnitude less. Regional maxima in electron densities that could give rise to Stark broadening was eliminated as a possibility. The measured electron densities did not exceed $10^9\ cm^{-3}$, and the axial variation was weak, showing less than a factor of two change throughout the brightest region of the plasma. The high mass diffusivity of all of the species present made it unlikely that a large density gradient existed anywhere in the plasma at steady state. This result was also evident by the good fit to a Gaussian profile recorded on the argon-hydrogen plasma rather than a Voigt profile as shown in Figure 10. In addition, the line broadening for Balmer β, γ, and δ was comparable to that of Balmer α; whereas, an absence of broadening beyond the instrument width was observed for the lines of argon or helium

species such as the 667.73 nm and 591.2 nm Ar I lines and 667.816 nm and 587.56 nm He I lines. Thus, the Stark broadening was also insignificant.

A linear Stark effect arises from an applied electric field that splits the energy level with principal quantum number n into $(2n-1)$ equidistant sublevels. The magnitude of this effect given by Videnovic et al. [8] is about $2\ X\ 10^{-2}\ nm/kV \cdot cm^{-1}$. No appreciable applied electric field was present in our study; thus, the linear Stark effect should be negligible. The absence of broadening of the noble gas lines and the hydrogen lines of the controls confirmed the absence of a strong electric field. No charged resonator cavity surfaces were present since the plasmas was contained in a quartz tube with the cavity external to the tube. A microwave E-mode field does exist in the Evenson cavity that is a function of the reflected power [37-38], and the catalysis reaction is dependent on this field as discussed previously [39]. However, there is no cathode fall region and the magnitude of the microwave field is comparably much less than that found in the cathode fall region of a glow discharge cell.

To investigate whether the rt-plasmas of this study were optically thin or thick at a given frequency ω, the effective path length $\tau_\omega(L)$ was calculated from

$$\tau_\omega(L) = \kappa_\omega L \tag{5}$$

where L is the path length and κ_ω is the absorption coefficient given by

$$\kappa_\omega = \sigma_\omega N_H \tag{7}$$

where σ_ω is the absorption cross section and N_H is the number density of the absorber. For optically thin plasmas $\tau_\omega(L) < 1$, and for optically thick plasmas $\tau_\omega(L) > 1$. The absorption cross section for Balmer α emission is $\sigma = 1\ X 10^{-16}\ cm^2$ [40]. By methods discussed previously [41-42], an estimate of the n=2 H atom density based on Lyman line intensity is $\sim 1\ X 10^{8}\ cm^{-3}$. Thus, for a plasma length of $5\ cm$, $\tau_\omega(5\ cm)$ for Balmer α is

$$\tau_\omega(5\ cm) = \kappa_\omega L = \left(1\ X\ 10^{-16}\ cm^2\right)\left(1\ X\ 10^{8}\ cm^{-3}\right)\left(5\ cm\right) = 5\ X\ 10^{-8} \tag{8}$$

Since $\tau_\omega(5) <<< 1$, the argon-hydrogen plasmas were optically thin; so, the self absorption of 656.3 nm emission by n=2 state atomic hydrogen may be neglected as a source of the observed broadening.

As discussed above, an estimate based on emission line profiles places the total H atom density of the argon-hydrogen

plasma at $\sim 3.5\,X\,10^{14}\,cm^{-3}$. Since this is overwhelmingly dominated by the ground state, $N_H = 3.5\,X10^{14}\,cm^{-3}$ will be used. Usually, the atomic hydrogen collisional cross section in plasmas is on the order of $10^{-18}\,cm^{2}$ [43]. Thus, for $N_H = 3.5\,X10^{14}\,cm^{-3}$, collisional or pressure broadening is negligible.

Section 51

Examiner Souw's erroneous analysis continues on pages 11-12 of the Appendix:

(f) Applicant's argument on pg.140-142 regarding Luque's and Luggenhoelscher's references has no merit, not only because the references are not cited by the Examiner to refute Applicant's incorrect claim of the Doppler effect and "hydrino" (this is accomplished by Kovacevic's [6] by virtue of the plasma sheath effect), but instead, to compare with the 0.27 nm line broadening measured by Applicant (see previous recitation from Applicant's paper). However, irrespective of the validity of Applicant's unverified Doppler assumption, a <u>proper</u> conversion of Luggenhoelscher's line broadening leads to a comparable magnitude (15.2 eV) with Applicant's claimed 10 eV kinetic energy, as previously demonstrated by the Examiner. Any further argument over line broadening in applicant's data of record will be considered unpersuasive for the reasons given in section I.B.3.d(5).

Examiner Souw's arguments are completely unfounded based on his lack of understanding that 3.7 cm-1 corresponds to only 4.5 meV, a trivial effect as discussed in Sections 42-44 above. His position that microwave fields have such an effect in Applicant's cells is refuted even by the paper cited by the Examiner:

S. Jovicevic, M. Ivkovic, N. Konjevic, S. Popovic, L. Vuskovic, J. Appl. Phys. 95, 24 (2004).

Section 52

Examiner Souw summarizes his erroneous analysis of Applicant's scientific evidence on page 12 of his Appendix by further arguing:

(C) <u>CONCLUSION</u>

> Not a single independent third party (one that is not funded by or in collaboration with applicant) has been able to confirm Applicant's claim(s). Therefore, serious doubts are raised as to the scientific reproducibility of Applicant's results. This situation is very similar to cold fusion, the latter having ultimately ended up with a final dismissal by the scientific community. Since Applicant's invention violates what is conventionally accepted in science, it is not patentable. Such an "invention" is also not useful, since it cannot be reproduced and used by others. Therefore, a rejection under § 101 and § 112/¶.1 is here proper.

The Examiner could not be more wrong. Applicant's results predicted by physical laws have been published in over 60 peer-reviewed journal articles and are disclosed in 112 articles, as summarized in the section entitled "Lower-Energy Hydrogen Experimental Data". Applicant's results have been replicated by many top laboratories as given in 51 independent test reports and papers summarized in the section entitled "Independent Test Results."

Section 53

Examiner Souw further concludes without adequate basis on page 12 of his Appendix that:

> In summary, Applicant's claims on hydrino-based processes have neither a credible experimental confirmation nor a scientific basis (see also Part IIof this Appendix: Theoretical).

In summary, the Examiner has not presented a single viable alternative to challenge Applicant's overwhelming body of evidence that confirms the claimed reaction of atomic hydrogen to lower-energy states and the existence of the claimed hydrino.

Studies that experimentally confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ($n = 1$) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds are summarized in the section entitled, "Lower-Energy Hydrogen Experimental Data" and include including:

extreme ultraviolet (EUV) spectroscopy,[13]
characteristic emission from catalysis and the hydride ion products,[14]
lower-energy hydrogen emission,[15]
plasma formation,[16]
Balmer α line broadening,[17]
population inversion of hydrogen lines,[18]
elevated electron temperature,[19]
anomalous plasma afterglow duration,[20]
power generation,[21]
excessive light emission,[22] and
analysis of chemical compounds.[23]

Section 54

In the Section of the Souw Appendix entitled **"II. Theoretical Part,"** on page 14, Examiner Souw posits the following arguments that are easily rebutted:

> Applicant's response does not remove any of the Examiner's refutations of his Grand Unified Theory of Quantum Mechanics, hereinafter GUT, as presented in the original Souw Appendix included in the previous office action. Rather, Applicant's response adds a large number of new mathematical and physical errors. Because those new errors are numerous, it is not possible to analyze them one by one without

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[13] Reference Nos. 11-16, 20, 24, 27-29, 31-36, 39, 42-43, 46-47, 50-52, 54-55, 57, 59, 63, 65-68, 70-76, 78-79, 81, 83, 85, 86, 89, 91-93, 95-96, 98, 101, 104, 108-112.

[14] Reference Nos. 24, 27, 32, 39, 42, 46, 51-52, 55, 57, 68, 72-73, 81, 89, 91, 108.

[15] Reference Nos. 14, 28-29, 33-36, 50, 63, 67, 70-71, 73, 75-76, 78-79, 86-87, 90, 92, 93, 98, 101, 104, 110-112.

[16] Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93, 108, 109.

[17] Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97, 105, 108, 109.

[18] Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91.

[19] Reference Nos. 34-37, 43, 49, 63, 67, 73.

[20] Reference Nos. 12-13, 47, 81.

[21] Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93, 98, 101, 104, 108, 110-112.

[22] Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72. 109

[23] Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94, 98, 100, 101, 104, 108, 110-112.

ending up writing hundreds of pages. Therefore, as done with GUT in the previous Appendix, only the significant ones will be addressed in the following sections, which are divided into the same paragraphs or sections as in the previous Appendix.

Applicant shows herein that the Examiner is stuck in his myopic view of quantum weirdness that prevents him from understanding and applying physical laws correctly. In fact, the Examiner is confused as to what constitutes a physical law. The Examiner argues that the postulated mathematics of SQM is a physical law. The reality is that SQM is incompatible with the physical laws of Maxwell, Newton, and special and general relativity, which is well known. The Examiner's failure to grasp this basic concept exposes yet another fatal flaw in his analysis.

Applicant has now solved hundreds of atomic problems such as ionization energies of multi-electron atoms, excited states, spectral fine structure and hyperfine structure, bonding parameters, ratios of the masses of fundamental, particles, the nature of the chemical bond and fundamental particles, and more. These results are in stunning agreement with the data. Applicant has also had his theory reviewed by outside experts, all Ph.D.'s with high credentials. These experts agree with Applicant that physical laws do apply on the atomic scale after all in contrast to the long-held views of quantum weirdness according to SQM.

Review by Dr. Jonathan Phillips

Review of "The Grand Unified Theory of Classical Quantum Mechanics" by Randell L. Mills

Jonathan Phillips, University of New Mexico Nat'l Lab Professor, Farris Engineering Center, Albuquerque, NM 87131

A dispassionate analysis of modifications in physics theory over the last decade indicates a new paradigm is needed. Theory now requires neutrinos to both have mass and travel at the speed of light, indicates that greater than 90% of the universe is "dark matter" or "dark energy" of unspecified form and origin, and is in search of a vast modification to virtual particle theory to explain the missing "quantum foam." An older and still valid reason to look for a new paradigm: There is still no explanation for the

postulated failure of Maxwell's equations "at the order of *h*." Even given the advantage of that postulate, QED cannot provide explanations of simple features of atoms such as the origin of electron spin, a reasonable derivation of the g-factor, or provide precise values of almost any of the features of multi-electron atoms, such as the energies of excited states. Using only Maxwell's equations and Newton's Laws, while explicitly ignoring Schrödinger's Equation, Dr. Mills has developed a revolutionary "new" quantum physics (Classical Quantum Mechanics, CQM), that to date has passed all experimental tests, and thus must be regarded as a valid scientific model. That is, without resort to a single adjustable parameter and employing only well known constants and standard laws of physics it provides precise quantitative agreement with one set of measured quantities after another. Not only does CQM yield quantitative agreement with data sets that overwhelm the current quantum paradigm, the solutions in most cases are simple, closed form algebraic solutions. If Occam's razor is our guide, Mills CQM is clearly the superior theory.

This reviewer finds the bound electron model to be compelling and complete, particularly because of the remarkable agreement with a wide range of data. The detailed and precise physical model of the bound electron, illustrated with excellent visual aids in the new edition, stands in sharp contrast to the hazy probability cloud of the QED paradigm. In the CQM model bound electrons are spherically symmetric shells of charge, with surface currents, that surround the atomic nucleus at quantized stable radii, the values of which can be determined using Maxwell's and Newton's Laws. In addition, the postulated current pattern of these physical electrons is shown to yield, simply using classical physics, the correct electron spin, and angular momentum. Moreover, the CQM model of the bound electron can solve, with computations performed easily using a spreadsheet, problems that have resisted the most intense applications of the conventional paradigm. Specifically, the CQM approach leads, for the first time, to closed form algebraic solutions that precisely describe the behavior of multi-electron atoms. For example, classical physics indicates that in order for the outer electron in a helium atom to be in a stable orbit it must see a central force equal to that required by Newton's Laws to keep an object in orbit. Those central forces for the outer electron in a helium atom will be a sum of the net electrostatic force of the enclosed electron and the enclosed protons, plus the magnetic interaction of the outer electron and inner electron. Thus, as Dr. Mills shows, classical physics leads to a simple force balance, which reduces to a cubic equation. This equation yields a single real solution for the radius. This radius is then used in the most elementary mechanics equations to yield the energy of each of the excited states. All excited states energies (more than 100), are readily *predicted* using as input to the final closed form equations only the "quantum numbers" of the states in question. For over 100 measured excited states of atomic helium the r^2 value is 0.999994, and the typical relative difference (measured-predicted/measured) is about 5 significant figures, which is within the error of the experimental data. There are no "fudge factors" such as "zero point energy" in the

equations, and the values for the constants are all taken from the NIST web pages. Moreover, the known scattering behavior of helium is in precise agreement with a sphere of the radius predicted by CQM. In contrast, in recent years the standard paradigm methods used to obtained these helium excited state energy values are not based in Schrödinger's equation, but rather complex (e.g., never closed form) derivative forms that invariably require the embrace of non-quantum concepts such as the existence of 'nodes' at which the 'functions' (not wave states) become "infinite." Also, probably due to both the computational resource investment required as well as the inaccuracy of the methods, no more than a handful of excited state energies are ever reported, and there is no basis given for assigning any of those values to particular excited states. The book details many other examples of success using the same CQM force balance approach. Applied to muonium, positronium, and hundreds of ionization energies this elegant, yet mathematically and physically simple, approach produces values in such close agreement with experiment that the results can only be described as stunning. In contrast, the many derivative QED approaches to these problems can best be described as torturous, inaccurate, and incomplete.

The scientific method compels Mills not merely to compare computations based on CQM theory with thoroughly vetted data sets, but to press forward with experimental tests of some of the more surprising predictions of the theory. Many of these are perfect for scientific tests as CQM predicts physical behavior completely at odds with that expected on the basis of conventional theory. Most extraordinary is the prediction that hydrogen can have hitherto undetected stable states in which the electron is at far lower energy levels, and hence the atom is physically smaller, than hydrogen in the almost universally accepted ground state. It is also predicted that transitions to these states will occur in specific mixed gas plasmas, including H_2/Ar, H_2/He and water. As outlined in the text, initial tests using EUV spectroscopy show the existence of spectral lines in precise agreement with this prediction of CQM. There is no conventional physics explanation for the presence of these lines in these mixed gas plasmas. The same is true of NMR spectra from products collected downstream from these plasmas, and careful calorimetry of the plasmas themselves. The calorimetry work shows as much as 30 W of excess energy from plasmas only a few centimeters in volume.

The implications of this new physics are unprecedented. Philosophically, we will move from a physical world which is at best stochastic, perhaps "uncertain," at the core, to a world of simple, immutable physical laws. Engineers will be challenged with the goal of tapping a new and apparently inexhaustible source of energy. Indeed, the new model makes it clear that potentially water can be "burned" to produce enormous energy (i.e. thousands of electron volts per hydrogen atoms) and a byproduct of inert hydrinos ("small hydrogen"), which Mills postulates are the missing dark matter of the universe. Given the success of the theory, which uses only classical physics, in producing simple closed formed solutions to observations that resisted decades of

computational effort to match them using the standard paradigm, the success of initial experimental tests of the model, as well as the revolutionary scientific and social implications of this theory, it is clear that the scientific community has an obligation to calmly and dispassionately test it.

Review by Dr. Shelby T. Brewer

Shelby T. Brewer is President of S. Brewer Enterprises, Inc. He was Chairman, President and CEO of ABB Combustion Engineering Nuclear Power Businesses from 1985 through 1995, accomplishing a major turnaround in this company, and positioning it as the world leader among nuclear suppliers. From 1981 through 1984, he was the top nuclear official in the Reagan Administration, as Assistant Secretary of Energy.

I grew up and was educated (1960s) in a time when Einstein's lifelong (but unattained) quest for a unified field theory was celebrated rather anecdotally, as a sort of historical curiosity. One spoke of theories as 'tools' or 'models'. The prevailing mentality was 'one model does not fit all.' A model would work and be useful in one set of circumstances, but not another; use a model to get practical results, but a pursuit of absolute unifying truth was regarded largely as a waste of candle wax.

Other characteristics of this time in science were intolerance, arrogance, and rigidity. Scientists preened and postured, became intensely political, and delegated the 'doing' of science to students. Science was becoming big science—a big governmental and corporate enterprise—demanding more resources and becoming less accountable. We now have an expensive standing army in American science, marching in place, with little creative, definable mission. Most of what passes for science is merely chauvinism—who has the largest accelerator, etc.

Now along comes Randell Mills. Without expending billions or even millions or even hundreds of thousands of US taxpayers' dollars, Dr. Mills has apparently completed Einstein's quest for a unified field theory. Dr. Mills' theory is presented in his book, *The Grand Unified Theory of Classical Quantum Mechanics* (July 2002). This is a huge achievement for three reasons. First, the Mills Theory tidies up theoretical physics by stitching together quantum mechanics and relativity. That in itself is a major triumph. Second, and more important, the Mills Theory explains several major empirical anomalies that have vexed physicists for decades: the sun's energy balance deficit; the dark matter in space phenomena; and mountains of atomic-electron spectral data that is inconsistent with prevailing theory. Third, the Mills Theory gives rise to the possibility

of an inexhaustible energy source based on phenomenology not yet recognized and accepted by the scientific community.

Remarkably, Dr. Mills has developed his theory and its energy generation application as an entrepreneur—without largesse from the US Government, and without the benediction of the US scientific priesthood. Because his enterprise does not suffer these two impediments, it just might succeed. If so, Mills will be the next Thomas Edison.

Shelby T. Brewer
Former Assistant Secretary of Energy
(Top Nuclear Official in the Reagan Administration)

Review by Dr. Günther Landvogt

Dr. Günther Landvogt, "The Grand Unified Theory of Classical Quantum Mechanics", International Journal of Hydrogen Energy, Vol. 28, No. 10, (2003), p. 1155.

In "The Grand Unified Theory of Classical Quantum Mechanics", Dr. Randell L. Mills really presents what the title promises: a theory which unifies Maxwell's equations, Newton's laws, and special and general relativity, electro-dynamics, mechanics, and gravity unified in a consistent theory, reaching from subatomic particles to cosmological dimensions. Only two ideas are basically new: (1) An unconventional, but logical use of Maxwell's equations resulting in a revolutionary interpretation of the electron; (2) A slight modification of general relativity resulting in a revolutionary model of the Universe. The rest of his theory is remarkably old: Mills believes—and verifies—that all the "classical" laws being valid in the "classical" branches of physics also hold in the atomic and subatomic fields. He presents a "classical" quantum mechanics that is simple, transparent, straightforward, consistent, and powerful. It does not need any postulates; the classical laws (including Einstein's) and physical constants are sufficient. Mills' quantum physics makes extensive use of Planck's constant, but avoids too much uncertainty. It is based on Maxwell's wave equation rather than Schrödinger's. The rich harvest is a heavy book filled with a firework of theoretical and practical consequences. Mills' ingenious way of thinking creates in different physical areas astonishing results with fascinating mathematical simplicity and harmony. And his theory is strongly supported by the fact that nearly all these results are in comfortable accordance with experimental findings, sometimes with breathtaking accuracy. Mills predicts fractional quantum energy levels of hydrogen and offers the quasi-chemical process to realize them. His experiments demonstrate that it represents the potential of a highly promising energy source. This is only one example of practical outcome. The book offers far more

and is a treasure for scientists and engineers who feel that they have a future. And Mills is still busy at work.

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Review by Dr. John J. Farrell

Dr. John J. Farrell
Professor of Chemistry, Emeritus
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February 10, 2004

The grand unified theory of classical quantum mechanics proposed by Randell L. Mills is breathtaking and powerful. Mills has successfully unified electrodynamics and gravity by applying Maxwell's equations, Newton's laws, and Einstein's special and general relativity with his exceptionally creative and quantitative mind.

Mills begins his theory by developing an entirely new description of the electron in the hydrogen atom (using Maxwell's equations). Unlike standard quantum mechanics, which describes the electron as a point particle, Mills finds that the electron is an infinite number great circles that comprise the surface of a sphere at the Bohr radius. The sum of the masses of all of the great circles is equal to the mass of one electron. Similarly, the sum of charges of all of the great circles is equal to the charge of one electron. After solving for the energy, the angular velocity and the radius of the electron (great circles), Mills derives the correct value for the angular momentum of the electron, h/2(. This is astonishing because theoreticians gave up on associating any systematic motion of the electron with its known angular momentum decades ago hence, the term intrinsic spin angular momentum. Amazingly, Mills goes on to derive, using the same motion of the electron but now considering its charge, the correct magnetic field and value of the magnetic moment of the electron. The chances of deriving the correct values for both the angular momentum and the magnetic moment of the electron without the correct motion of the electron is, quite frankly, zero. Mills must have the correct motion of the electron in the hydrogen atom. Armed with this knowledge, he then derives the values of all of the known physical parameters of the hydrogen atom.

The fun does not stop there. Mills goes on to derive hundreds of physical parameters, such as the masses of leptons, quarks, and gluons. He makes predictions for many aspects of nature for which we do not have known values and for which the predicted values are unanticipated: the acceleration of the expansion of the cosmos; the existence of old galaxies at the beginning of the current cosmological expansion; the maximum and minimum radii of the universe and how long it takes to complete one cycle about 1,000 billion years to go from minimum to maximum and back to minimum again. He not only predicts fractional quantum states for the hydrogen atom (n = 1/2, 1/3, 1/4, Ö), he has identified the extreme ultraviolet spectral lines that result from their formation in hydrogen/helium plasmas.

Mills' grand unified theory of classical quantum mechanics explains the answers to some very old scientific questions, such as what happens to a photon upon absorption and some very modern ones, such as what is dark matter. His theory explains why the Sun's corona is so hot (>1,000,000 K) in spite of the fact that Sun's surface is so cool (6,000 K). Astounding.

What does all of this mean to the average person? A lot. The technology that ensues from Mills' theory will change almost every facet of life for everyone on the planet. The most immediate change will be in how we produce and use energy. The obtainable energies from the catalytic formation of fractional quantum states of hydrogen are intermediate between normal chemical energies and nuclear energies. The advantage here is that the fuel is abundant, non-polluting hydrogen. Scientists, engineers, and economists have touted the hydrogen economy for several decades. Little did they know that it would take the form of catalytically converting hydrogen to lower energy states of hydrogen! Truly, reality is stranger than fiction. The possibilities of this one aspect, energy production, boggle the mind. Furthermore, lower energy hydrogen will double (quadruple?) known chemistry. These smaller-than-normal hydrogen atoms should form chemical bonds that are two to ten times stronger than any known chemical bond. Imagine the strong fibers, the hard surfaces, the materials that will last for decades or centuries without corrosion, the extremely high-voltage batteries that will be possible all made with the light element hydrogen. Have I mentioned the implications of correctly understanding gravity?

Lastly, Mills has made an extremely important contribution to the philosophy of science. He has reestablished cause and effect as the basic principle of science. Probability and chance will still rule at Las Vegas and Atlantic City, but not in the laboratory. Einstein would be pleased.

Multiple theory papers are also accepted for publication in peer-reviewed journals.

Section 55

Examiner Souw continues his error-prone analysis with the following statements appearing on page 14 of his Appendix:

1. **Regarding the derivation of hydrino's fractional energy levels, E_n**

> (a) Applicant's arguments regarding GUT, Ch. 1-2, 5-6, as recited in his response on pg.37 are unpersuasive: Applicant's formula for E_n is not derived, but postulated, just as stated by the Examiner so far. First-principle means, the principal formula must come out of mathematical derivation. Thus, applicant's formula is not from first principles. It is to be known, that postulate is acceptable in science (e.g., QM), insofar it is supported by experimental evidence and does not contradict with known natural laws. This is not the case with the hydrino. Its existence is not supported by experimental evidence and is also in violation of quantum mechanics (QM), electrodynamics, and the relativity theory.

The hydrino states are derived from Maxwell's equations and other first principle laws in GUT, Ch. 1-2, 5-6. This can be confirmed by the comparing the match between predictions and experiment observations of conjugate observables using the same solution of the one electron atom as used to derive the hydrino states.

Some of the many confirmatory results are:

STERN-GERLACH EXPERIMENT

The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s ($s=\frac{1}{2}$; $m_s=\pm\frac{1}{2}$). The superposition of the vector projection of the orbitsphere angular momentum on the z-axis is $\frac{\hbar}{2}$ with an orthogonal component of $\frac{\hbar}{4}$. Excitation of a resonant Larmor

precession gives rise to $\hbar$ on an axis $\mathbf{S}$ that precesses about the z-axis called the spin axis at the Larmor frequency at an angle of $\theta = \frac{\pi}{3}$ to give a perpendicular projection of

$$\mathbf{S}_{\perp} = \pm\sqrt{\frac{3}{4}}\hbar \tag{1}$$

and a projection onto the axis of the applied magnetic field of

$$\mathbf{S}_{\parallel} = \pm\frac{\hbar}{2} \tag{2}$$

The superposition of the $\frac{\hbar}{2}$, z-axis component of the orbitsphere angular momentum and the $\frac{\hbar}{2}$, z-axis component of $\mathbf{S}$ gives $\hbar$ corresponding to the observed electron magnetic moment of a Bohr magneton, μ_B.

ELECTRON g FACTOR

Conservation of angular momentum of the orbitsphere permits a discrete change of its "kinetic angular momentum" $(\mathbf{r} \times m\mathbf{v})$ by the applied magnetic field of $\frac{\hbar}{2}$, and concomitantly the "potential angular momentum" $(\mathbf{r} \times e\mathbf{A})$ must change by $-\frac{\hbar}{2}$.

$$\Delta\mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \tag{3}$$

$$= \left[\frac{\hbar}{2} - \frac{e\phi}{2\pi}\right]\hat{z} \tag{4}$$

In order that the change of angular momentum, $\Delta\mathbf{L}$, equals zero, ϕ must be $\Phi_0 = \frac{h}{2e}$, the magnetic flux quantum. The magnetic moment of the electron is parallel or antiparallel to the applied field only. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla \bullet (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right] - \frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right] - \mathbf{J} \bullet \mathbf{E} \tag{5}$$

Eq. (6) gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively,

$$\Delta E_{mag}^{spin} = 2\left(1 + \frac{\alpha}{2\pi} + \frac{2}{3}\alpha^2\left(\frac{\alpha}{2\pi}\right) - \frac{4}{3}\left(\frac{\alpha}{2\pi}\right)^2\right)\mu_B B \tag{6}$$

$$\Delta E_{mag}^{spin} = g\mu_B B \tag{7}$$

where the stored magnetic energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right]$ term increases, the stored electric energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right]$ term increases, and the $\mathbf{J} \bullet \mathbf{E}$ term is dissipative. The spin-flip transition can be considered as involving a magnetic moment of g times that of a Bohr magneton. The g factor is redesignated the fluxon g factor as opposed to the anomalous g factor. Using $\alpha^{-1} = 137.03603(82)$, the calculated value of $\frac{g}{2}$ is $\mathbf{1.001\ 159\ 652\ 137}$. The experimental value [1] of $\frac{g}{2}$ is $\mathbf{1.001\ 159\ 652\ 188(4)}$.

References

1. R. S. Van Dyck, Jr., P. Schwinberg, H. Dehmelt, "New high precision comparison of electron and positron g factors", Phys. Rev. Lett., Vol. 59, (1987), p. 26-29.

Lamb Shift

The Lamb Shift of the $^2P_{1/2}$ state of the hydrogen atom is due to conservation of energy and linear momentum of the emitted photon, electron, and atom.

Electron Component

$$\Delta f = \frac{\Delta\omega}{2\pi} = \frac{E_{h\upsilon}}{h} = \frac{(E_{h\upsilon})^2}{2h\mu_e c^2} = 1052.48\ MHz$$

where $E_{h\upsilon}$ is

$$E_{h\nu} = 13.5983\ eV\left(1 - \frac{1}{n^2}\right)\frac{3}{4\pi}\sqrt{\frac{3}{4}} - h\Delta f$$

$$h\Delta f <<< 10\ eV; \quad n = 2$$

$$\therefore E_{h\nu} = 13.5983\ eV\left(1 - \frac{1}{2^2}\right)\frac{3}{4\pi}\sqrt{\frac{3}{4}}$$

Atom Component

$$\Delta f = \frac{\Delta\omega}{2\pi} = \frac{E_{h\upsilon}}{h} = \frac{(E_{h\upsilon})^2}{2hm_H c^2} = \frac{\left(13.5983\ eV\left(1 - \frac{1}{2^2}\right)\left(1 + \frac{1}{2} - \sqrt{\frac{3}{4}}\right)\right)^2}{2hm_H c^2} = 5.3839\ MHz$$

Sum of Components

$$\Delta f = 1052.48\ MHz + 5.3839\ MHz = 1057.87\ MHz$$

The experimental Lamb Shift is $\Delta f = 1057.862\ MHz$

The other core results of SQM can be replicated using closed form equations containing fundamental constants only without involving renormalization and virtual particles. The results derived from Maxwell's equations are in remarkable agreement between the calculated and experimental values that are only limited by the accuracy of the fundamental constants.

FINE STRUCTURE

The fine structure energy is the Lamb-shifted relativistic interaction energy between the spin and orbital magnetic moments due to the corresponding angular momenta.

The energy, E_{FS} and frequency, Δf_{FS}, for the ${}^2P_{3/2} \rightarrow {}^2P_{1/2}$ transition called the fine structure splitting is given by the sum:

$$E_{FS} = \frac{\alpha^5 (2\pi)^2}{8} m_e c^2 \sqrt{\frac{3}{4}} + \left(13.5983\ eV\left(1 - \frac{1}{2^2}\right)\right)^2 \left[\frac{\left(\frac{3}{4\pi}\left(1 - \sqrt{\frac{3}{4}}\right)\right)^2}{2h\mu_e c^2} + \frac{\left(1 + \left(1 - \sqrt{\frac{3}{4}}\right)\right)^2}{2hm_H c^2} \right]$$

$$= 4.5190\, X\, 10^{-5}\ eV + 1.75407\, X\, 10^{-7}\ eV$$
$$= 4.53659\, X\, 10^{-5}\ eV$$

$$\Delta f_{FS} = 10{,}927.0\ MHz + 42.4132\ MHz = 10{,}969.4\ MHz$$

The energy of $4.53659\ X\, 10^{-5}\ eV$ corresponds to a frequency of $10{,}969.4\ MHz$, or a wavelength of $2.73298\ cm$.

The experimental value of the ${}^2P_{3/2}$—${}^2P_{1/2}$ transition frequency is $10{,}969.1\ MHz$.

HYPERFINE STRUCTURE

The hyperfine structure of the hydrogen atom is calculated from the force balance contribution between the electron and the proton.

The energy corresponds to the Stern-Gerlach and stored electric and magnetic energy changes.

The total energy of the transition from antiparallel to parallel alignment, $\Delta E_{total}^{S/N}$, is given as the sum:

$$\begin{aligned}\Delta E_{total}^{S/N} &= -\mu_0 \mu_B \mu_P \sqrt{\frac{3}{4}}\left(\frac{1}{r_+^3}+\frac{1}{r_-^3}\right)+\frac{-e^2}{8\pi\varepsilon_o}\left[\frac{1}{r_+}-\frac{1}{r_-}\right]+\left(-1-\left(\frac{2}{3}\right)^2-\frac{\alpha}{4}\right)4\pi\mu_o\mu_B^2\left(\frac{1}{r_+^3}-\frac{1}{r_-^3}\right)\\ &= -1.918365\,X\,10^{-24}\,J + 9.597048\,X\,10^{-25}\,J + 1.748861\,X\,10^{-26}\,J\\ &= -9.411714\,X\,10^{-25}\,J\end{aligned}$$

where

$$r = a_H \pm \frac{2\pi\alpha\,\mu_P}{ec}\sqrt{\frac{3}{4}}$$

The energy is expressed in terms of wavelength using the Planck relationship:

$$\lambda = \frac{hc}{\Delta E_{total}^{S/N}} = 21.10610\;cm$$

The experimental value from the hydrogen maser is $21.10611\;cm$.

MUONIUM HYPERFINE STRUCTURE INTERVAL

The hyperfine structure of muonium is calculated from the force balance contribution between the electron and muon.

The energy corresponds to the Stern-Gerlach and stored electric and magnetic energy changes.

The energy of the ground state ($1^2S_{1/2}$) hyperfine structure interval of muonium, $\Delta E(\Delta \nu_{Mu})$, is given by the sum:

$$\Delta E(\Delta \nu_{Mu}) = -\mu_0 \mu_B \mu_\mu \sqrt{\frac{3}{4}}\left(\frac{1}{r_{2+}^3}+\frac{1}{r_{2-}^3}\right) + \frac{-e^2}{8\pi\varepsilon_o}\left[\frac{1}{r_{2+}}-\frac{1}{r_{2-}}\right]$$
$$+4\pi\mu_o\left(-1-\left(\frac{2}{3}\cos\frac{\pi}{3}\right)^2-\alpha\right)\left(\mu_B^2\left(\frac{1}{r_{2+}^3}-\frac{1}{r_{2-}^3}\right)+\mu_{B,\mu}^2\left(\frac{1}{r_{1+}^3}-\frac{1}{r_{1-}^3}\right)\right)$$
$$= -6.02890320\ X\,10^{-24}\ J + 3.02903048\ X\,10^{-24}\ J + 4.23209178\ X10^{-26}\ J + 1.36122030\ X\,10^{-28}\ J$$
$$= -2.95741568\ X\,10^{-24}\ J$$

where

$$r_2 = a_\mu \pm \frac{2\pi\alpha\,\mu_\mu}{ec}\sqrt{\frac{3}{4}}$$

and

$$r_1 = \frac{a_\mu \pm \frac{2\pi\alpha\,\mu_\mu}{ec}\sqrt{\frac{3}{4}}}{\left(\frac{m_\mu}{m_e} \pm \frac{m_\mu e\alpha c}{2\hbar^2}\mu_0\,\mu_\mu\sqrt{\frac{3}{4}}\right)^{1/3}}$$

Using Planck's equation, the interval frequency, $\Delta\nu_{Mu}$, and wavelength, $\Delta\lambda_{Mu}$, are

$$\Delta\nu_{Mu} = 4.46330328\ GHz$$
$$\Delta\lambda_{Mu} = 6.71682919\ \text{cm}$$

The experimental hyperfine structure interval of muonium is

$$\Delta E(\Delta \nu_{Mu}) = -2.957415336\ X 10^{-24}\ J$$
$$\Delta \nu_{Mu} = 4.463302765(53)\ GHz\ (12\, ppm)$$
$$\Delta \lambda_{Mu} = 6.71682998 \text{ cm}$$

POSITRONIUM HYPERFINE STRUCTURE

The leptons are at the same radius, and the positronium hyperfine interval is given by the sum of the Stern-Gerlach, $\Delta E_{\text{spin-spin}}$, and fine structure, $\Delta E_{s/o}({}^3S_1 \rightarrow {}^1S_0)$, energies.

The hyperfine structure interval of positronium (${}^3S_1 \rightarrow {}^1S_0$) is given by the sum:

$$\begin{aligned}
\Delta E_{\text{Ps hyperfine}} &= \Delta E_{\text{spin-spin}} + \Delta E_{s/o}({}^3S_1 \rightarrow {}^1S_0) \\
&= \frac{g\mu_o e^2 \hbar^2}{8 m_e^2 (2a_0)^3} + \frac{3g\alpha^5 (2\pi)^2}{8} m_e c^2 \sqrt{\frac{3}{4}} \\
&= \frac{g\alpha^5 (2\pi)^2}{8} m_e c^2 \left(\frac{1}{8\pi\alpha} + \frac{3\sqrt{3}}{2} \right) \\
&= 8.41155110\ X 10^{-4}\ eV
\end{aligned}$$

Using Planck's equation, the interval in frequency, $\Delta \upsilon$, is

$$\Delta \upsilon = 203.39041\ GHz$$

The experimental ground-state hyperfine structure interval is

$$\Delta E_{\text{Ps hyperfine}}(\text{experimental}) = 8.41143\ X 10^{-4}\ eV$$
$$\Delta \upsilon(\text{experimental}) = 203.38910(74)\ GHz\ (3.6\, ppm)$$

The relativistic one-electron atom ionization energies in closed-form equations with fundamental constants are given by

$$\gamma^* = \frac{2\pi}{2\pi\sqrt{1-\left(\frac{v}{c}\right)^2}\sin\left[\frac{\pi}{2}\left(1-\left(\frac{v}{c}\right)^2\right)^{3/2}\right]+\cos\left[\frac{\pi}{2}\left(1-\left(\frac{v}{c}\right)^2\right)^{3/2}\right]} \tag{1.250}$$

$$E_{ele} = -\gamma^* \frac{Z^2 e^2}{8\pi\varepsilon_o a_0}\frac{\mu}{m_e} = -\gamma^* \frac{\mu}{m_e} Z^2 X\, 2.1799\, X\, 10^{-18}\, J = -\gamma^* \frac{\mu}{m_e} Z^2 X\, 13.606\, eV \tag{1.251}$$

Table 1.5. Relativistically corrected ionization energies for some one-electron atoms.

One e Atom	Z	γ^* a	Theoretical Ionization Energies (eV) b	Experimental Ionization Energies (eV) c	Relative Difference between Experimental and Calculated d
H	1	1.000007	13.59838	13.59844	0.00000
He^{+}	2	1.000027	54.40941	54.41778	0.00015
Li^{2+}	3	1.000061	122.43642	122.45429	0.00015
Be^{3+}	4	1.000109	217.68510	217.71865	0.00015
B^{4+}	5	1.000172	340.16367	340.2258	0.00018
C^{5+}	6	1.000251	489.88324	489.99334	0.00022
N^{6+}	7	1.000347	666.85813	667.046	0.00028
O^{7+}	8	1.000461	871.10635	871.4101	0.00035
F^{8+}	9	1.000595	1102.65013	1103.1176	0.00042
Ne^{9+}	10	1.000751	1361.51654	1362.1995	0.00050
Na^{10+}	11	1.000930	1647.73821	1648.702	0.00058
Mg^{11+}	12	1.001135	1961.35405	1962.665	0.00067
Al^{12+}	13	1.001368	2302.41017	2304.141	0.00075
Si^{13+}	14	1.001631	2670.96078	2673.182	0.00083
P^{14+}	15	1.001927	3067.06918	3069.842	0.00090
S^{15+}	16	1.002260	3490.80890	3494.1892	0.00097
Cl^{16+}	17	1.002631	3942.26481	3946.296	0.00102
Ar^{17+}	18	1.003045	4421.53438	4426.2296	0.00106
K^{18+}	19	1.003505	4928.72898	4934.046	0.00108
Ca^{19+}	20	1.004014	5463.97524	5469.864	0.00108
Sc^{20+}	21	1.004577	6027.41657	6033.712	0.00104
Ti^{21+}	22	1.005197	6619.21462	6625.82	0.00100
V^{22+}	23	1.005879	7239.55091	7246.12	0.00091
Cr^{23+}	24	1.006626	7888.62855	7894.81	0.00078
Mn^{24+}	25	1.007444	8566.67392	8571.94	0.00061
Fe^{25+}	26	1.008338	9273.93857	9277.69	0.00040
Co^{26+}	27	1.009311	10010.70111	10012.12	0.00014
Ni^{27+}	28	1.010370	10777.26918	10775.4	-0.00017
Cu^{28+}	29	1.011520	11573.98161	11567.617	-0.00055

a From theoretical calculations, interpolation of H isoelectronic and Rydberg series, and experimental data [43-44].

b (Experimental-theoretical)/experimental.

43. C. E. Moore, "Ionization Potentials and Ionization Limits Derived from the Analyses of Optical Spectra, Nat. Stand. Ref. Data Ser.-Nat. Bur. Stand. (U.S.), No. 34, 1970.
44. D. R. Lide, *CRC Handbook of Chemistry and Physics*, 79 th Edition, CRC Press, Boca Raton, Florida, (1998-9), p. 10-175 to p. 10-177.

These results can not be matched with SQM, which is not predictive. They also disprove the Examiner's position that the hydrino states are not derived.

Section 56

Examiner Souw further argues on page 15 of his Appendix that:

(b) As already demonstrated in said Appendix, those GUT chapters are full of mathematical flaws and violations of elementary principles of physics, some of which have been previously discussed and will be consequently prosecuted in the following sections.

These results are derived from physical laws and do not contain mathematical errors as confirmed by the remarkable agreement between the calculated and experimental results and as confirmed by independent peer review as discussed in Sections 54-55 above. The Examiner's inability to overcome these stunning results is patently obvious and only further highlights the bias inherent in his faulty analysis.

Section 57

Examiner Souw further states on page 15 of his Appendix:

2. Regarding the alleged "electrostatic Schrödinger Equation (SE)" and "stationary electron"

(a) Applicant has misrepresented the Examiner's previous statements as none of the wording alleged by Applicant, i.e., "electrostatic Schrödinger Equation (SE)" and "stationary electron" is recited by the Examiner in said Appendix. As such, the Examiner is not giving any weight to these arguments thus presented.

Examiner Souw, however, has not provided a basis for the stability of a point electron bound to a proton. It must radiate according to Maxwell's equations. More on the instability of the hydrogen atom according to SQM is given below.

Section 58

Examiner Souw continues with his erroneous analysis on pages 15-16 of his Appendix, arguing that:

> (b) Applicant has misunderstood the fundamental QM concept of "stationary state" (see original Souw Appendix pg. 1/ sect.2/lines I and 3), in which the term "stationary" (or "static") simply means "does not change with time" (as defined in the Appendix pg.2/line 1). This "stationary state" is a fundamental concept that can be found in every QM textbook (see, e.g., McQuarrie [1], Ch.4.3, pg. 121, lines 2-3 from bottom, *"Thus, the probability density and the averages calculated from Eq. 4-19 are independent of time, and the $ø_n(x)$ are called stationary-state wave functions".* As such, the wording "stationary state" would never be misinterpreted as "motionless electron" by any one of ordinary skill in the art. As known in the art, an electron in a stationary state is in motion, wherein the motion, or velocity, is inherent in the wavefunction, and is represented by the eigenvalue (for a single state) or expectation value (for a superposition of states) of the particle momentum operator ***p*** (operators are written in *bold italics)* divided by the mass m (scalar non-operator), i.e., ***V=p/m,*** such that the particle velocity is <***V***> = (1/m)?<ø*,***p***ø>, in which the operator ***p*** is represented by -i_ **grad** in the Schrödinger representation. The "stationary" state or "static" probability density (to be distinguished from Applicant's stationary electron) is a direct consequence of the uncertainty relation (see original Souw Appendix/lines 8-10), since the energy E of the state, and also its angular momentum L, are sharply defined, i.e., äE=O and äL=O, which consequently leads to ät=? (does not change with time) and äö=2∂ (total uncertainty of angular position ö), the latter because the angular momentum operator is defined as ***L***=i_?/?? (or by scalar operator ***L***^{2}*)*, and the complementary of the angular momentum is the angular position p, which is equivalent to the complementarity between ***p*** and ***x***, leading to äx=? for äp=0 in case of linear momentum and position. In simple terms understandable to those ordinarily skilled in the art, an electron plane wave represented by ø~exp(ikx-iùt) also results in a stationary probability (charge) density, p = |ø|^2 = constant in time, i.e., static, per definition. However, the electron itself (to be distinguished from its state or probability density) is not stationary or static, but instead,

moving with a momentum of p=_k and a kinetic energy of $E=\_^2k^2/2m$. This is a most basic element of QM well known to-those ordinarily skilled in the art. For these reasons, Applicant's "refutation" of the QM are unpersuasive.

These arguments have no merit inasmuch as Examiner Souw presents an impossible situation—that of a moving point electron that is **always** constant in its position/distribution. Furthermore, the Examiner contradicts himself once again by stating that the average distribution is constant. This is very different from the instantaneous position being constant. It is the inconstancy of the latter that must give rise to radiation.

It is well known that the Bohr model gives a constant average position/distribution of the harmonic motion, but it is also predicted to radiate due to the instantaneous motion that is not constant.

Section 59

On pages 16-17 of his Appendix, Examiner Souw once again erroneously argues that:

> The QM method of calculating spectral line intensities based on vector- and tensoroperators as presented, e.g., by Condon EU. & Shortley G.H., "The Theory of Atomic Spectra", Cambridge 1967, pp. 45-69, and 112-147 [2], has been mathematically implemented and experimentally verified by the Examiner himself in his two previously cited works [3, 4]. The experimental verification involving hundreds of spectral lines as functions of electric/magnetic fields was made without a single error or failure. The results were extremely accurate within less than 10^{-5} nm, which is far more superior to the 0.1 nm accuracy achieved in Applicant's measurements. As a proof for the correctness of conventional QM, similar mathematical verifications have been also demonstrated by a great number of other authors. In this regard, a reference to the Examiner's own work is here to be considered important, so as to exclude the possibility of an invalid dismissal from Applicant's side, such as "the Examiner misunderstands his own reference". As already brought up in the previous Appendix, Applicant's Grand Unified Theory (GUT) wave function is incapable of calculating line splitting and line intensities, including line

absorption cross-sections, as the conventional QM is evidently capable of (see [2], [3] and [4]). Applicant is invited to present detailed step-by-step calculations showing how his theory is capable of predicting the line intensities and applicant has not done so to date.

The supposedly accurate results of quantum mechanics for spectral lines are easily explainable—they are due to the remarkable ability to use computers for curve fitting. The Examiner has provided no evidence that any calculation based on SQM is grounded in physical laws. Applicant has now calculated the excited state spectrum of helium in closed-form equations with fundamental constants only. The agreement of the precise values obtained by inserting the quantum number of the state into the equations is in remarkable agreement with the NIST values for over 100 reported states. The same solutions predict the other conjugate parameters of the helium atom for the first time. These results have not been matched by SQM in the 80 years of its existence.

The abstract is given as follows:

106. **R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Foundation Louis de Broglie, submitted.**

Quantum mechanics (QM) and quantum electrodynamics (QED) are often touted as the most successful theories ever. In this paper, this claim is critically evaluated by a test of internal consistency for the ability to calculate the conjugate observables of the nature of the free electron, ionization energy, elastic electron scattering, and the excited states of the helium atom using the same solution for each of the separate experimental measurements. It is found that in some cases quantum gives good numbers, but the solutions are meaningless numbers since each has no relationship to providing an accurate physical model. Rather, the goal is to mathematically reproduce an experimental or prior theoretical number using adjustable parameters including arbitrary wave functions in computer algorithms with precision that is often much greater (e.g. 8 significant figures greater) than possible based on the propagation

of errors in the measured fundamental constants implicit in the physical problem. Given the constraints of adherence to physical laws and internal consistency, an extensive literature search indicates that quantum mechanics has never solved a single physical problem correctly including the hydrogen atom and the next member of the periodic chart, the helium atom. Rather than using postulated unverifiable theories that treat atomic particles as if they were not real, physical laws are now applied to the same problem. In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, a classical approach is explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level. The proverbial view deeply seated in the wave-particle duality notion that there is no large-scale physical counterpart to the nature of the electron is shown not to be correct. Physical laws and intuition may be restored when dealing with the wave equation and quantum atomic problems. Specifically, a theory of classical quantum mechanics (CQM) was derived from first principles as reported previously [1-6] that successfully applies physical laws to the solution of atomic problems that has its basis in a breakthrough in the understanding of the stability of the bound electron to radiation. Rather than using the postulated Schrödinger boundary condition: "$\Psi \rightarrow 0$ as $r \rightarrow \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy.* Although it is well known that an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. A simple invariant physical model arises naturally wherein the predicted results are extremely straightforward and internally consistent requiring minimal math as in the case of the most famous equations of Newton, Maxwell, Einstein, de Broglie, and Planck on which the model is based. No new physics is needed; only the known physical laws based on direct observation are used. The accurate solution of the helium atom is confirmed by the agreement of predicted and observed conjugate parameters using the same unique physical model in all cases.

Applicant has also correctly calculated the energy levels for over 100 Stark split states of hydrogen, derived correctly the selection rules and derived the equation for line intensities in Ref. #1 (GUT Chp. 2), a truly remarkable accomplishment.

What is not so remarkable is that the Examiner can not see past his own biases to allow himself to even consider Applicant's evidence objectively.

Section 60

The inconsistencies that predominate Examiner Souw's analysis can also be found on pages 17-18 of the Appendix, which states:

> (c) Regarding pg.40 of the amendment, the Examiner's argument has been (and is),that not only the ground state, but all stationary states must be also non-radiative in consequence of the Haus theorem, since their probability density distribution does not change with time (i.e., per definition, stationary; see previous Appendix section 2, lines 1-2). To "see" an electron physically moving around an atom, a wave packet has to be constructed as a superposition of stationary states having not only a plurality of orbital quantum numbers (L,m), as described in the original Souw Appendix, sect.2, but also involving at least two principal quantum numbers, n_1 and n_2, as discussed in the original Appendix sect.3. Only then, can a non-vanishing time dependence of the probability density be established, i.e., by virtue of the cross-term p = $|ø|^2$~exp i($ù_1$¯$ù_2$)·t (Note: the energy of a free hydrogen atom, and hence, its frequency, $ù_n$=E_n/_, only depends on the principal quantum number n). This corresponds to the transition probability discussed in sect.3 of the original Appendix, which also agrees with the Haus's condition, that a free hydrogen atom composed of at least two eigenstates of different principal quantum numbers does radiate, i.e., making a transition from n_2-state to n_1-state.

Here again, Examiner Souw makes an internally inconsistent argument in claiming that "not only the ground state, but all stationary states must be also non-radiate in consequence of the Haus theorem". Then he states that " a free hydrogen atom composed of at least two eigenstates of different principal quantum numbers does radiate, i.e., making a transition from n_2-state to n_1-state". Such inconsistencies only add to the fatal flaws plaguing the Examiner's erroneous analysis.

Section 61

Examiner Souw further argues on page 18 of his Appendix that:

This conclusion regarding stationary states is a direct consequence of the Heisenberg Uncertainty Principle, and has been made by the Examiner independent from --but in agreement with-- Feynman and other authorities in QM, the latter contended by the Applicant himself (see 2.d.(5) below).

Other authorities, including theoreticians from Princeton University, agree with Applicant that the Feynman argument that the stability of the hydrogen atom is based on the Heisenberg Uncertainty Principle is false.

Under SQM, the electron is not stable to radiation and states of lower energy than the n=1 state are not precluded. This point is shown by Applicant's analysis [80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted] as well as by other theoreticians such as those at Princeton University who show that the Heisenberg Uncertainty Principle provides no atomic stability [E. H. Lieb, "The stability of matter", Reviews of Modern Physics, Vol. 48, No. 4, (1976), pp, 553-569]. The abstract of Ref. #80 is given below:

Abstract

Recently published data showing that the Rydberg series extends to lower states in a catalytic plasma reaction [R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542] has implication for the theoretical basis of the stability of the hydrogen atom. The hydrogen atom is the only real problem for which the Schrödinger equation can be solved without approximations; however, it only provides three quantum numbers—not four, and inescapable disagreements between observation and predictions arise from the later postulated Dirac equation as well as the Schrödinger equation. Furthermore, unlike physical laws such as Maxwell's equations, it is always disconcerting to those that study quantum mechanics (QM) that the particle-wave equation and the intrinsic Heisenberg Uncertainty Principle (HUP) must be accepted without any underlying physical basis for fundamental observables such as the stability of the hydrogen atom in the first place. In this instance, a circular argument regarding definitions for parameters in the wave equation solutions and the Rydberg series of spectral lines replaces a first-principles-based prediction of those lines. It is shown that the quantum

theories of Bohr, Schrodinger, and Dirac provide no intrinsic stability of the hydrogen atom based on physics. An old argument from Feynman based on the HUP is shown to be internally inconsistent and fatally flawed. This argument and some more recent ones further brings to light the many inconsistencies and shortcomings of QM and the intrinsic HUP that have not been reconciled from the days of their inception. The issue of stability to radiation needs to be resolved, and the solution may eliminate of some of the mysteries and intrinsic problems of QM.

Section 62

On page 18 of the Souw Appendix, the Examiner makes the following astounding statement:

> In contrast, Applicant's theory based on point electron, as recited in GUT and on pg.39 is incorrect, since it is in total contradiction to and not reconcilable with the routine experimental observations of electron wave properties, such as interference effects that have found many useful applications, e.g., Reflection High Energy Electron Diffraction (RHEED) and Low Energy Electron Diffraction (LEED).

It is hard to believe that the Examiner has read anything on CQM. The fundamental premise of CQM is that the electron is not a point such **as it is in SQM**. For special extended distributions, acceleration without radiation is possible. On this basis, the extended charge-density functions are derived from Maxwell's equations. To assist the Examiner in understanding this concept, a picture of the bound and free electron charge (mass)-density functions are given below:

Figure 1.1. The orbitsphere is a two-dimensional spherical shell of zero thickness with the Bohr radius of the hydrogen atom, $r = a_H$. It is nonradiative, a minimum-energy surface, and extremely stable in that the balanced forces correspond to a pressure of twenty million atmospheres.

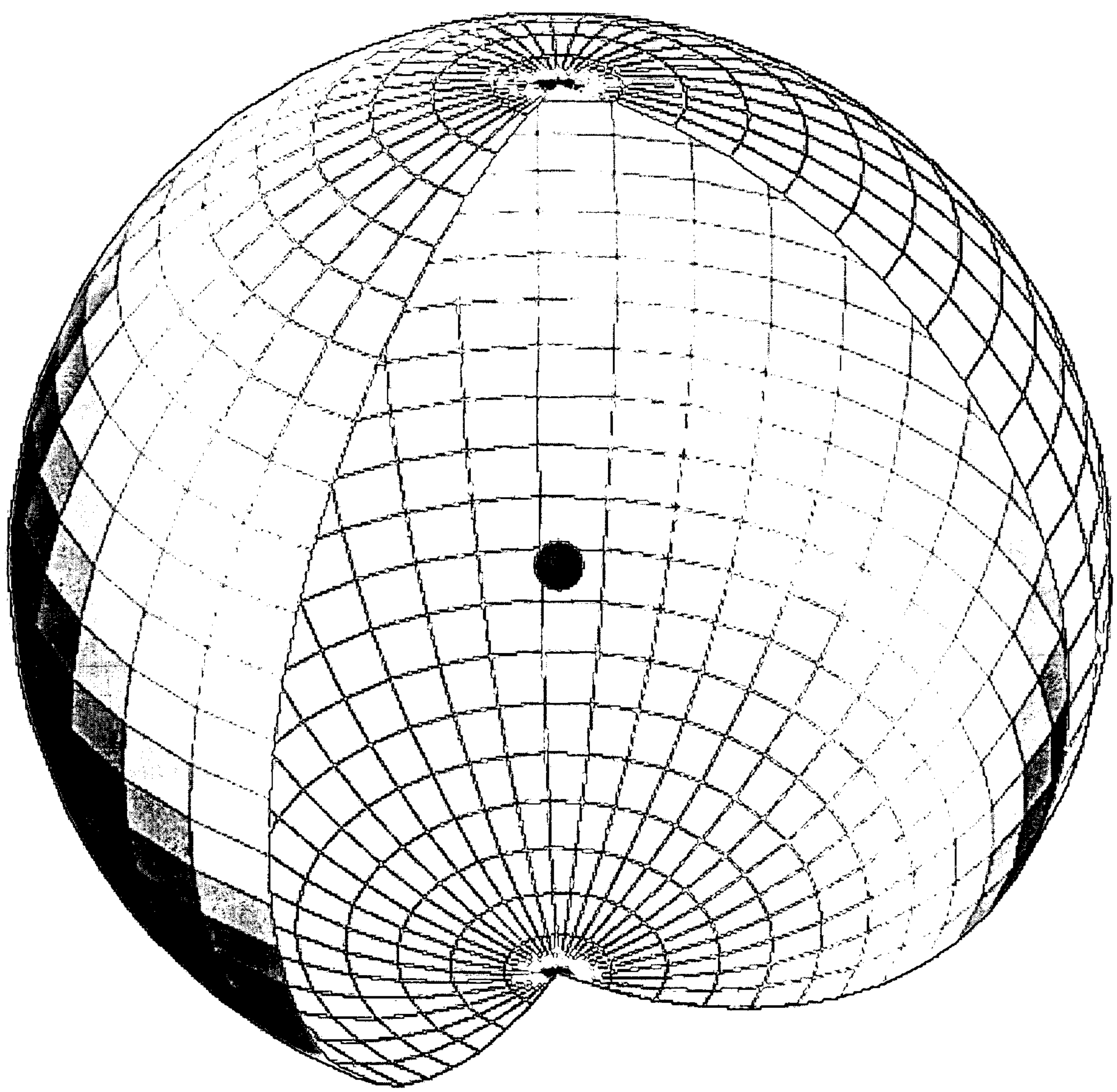
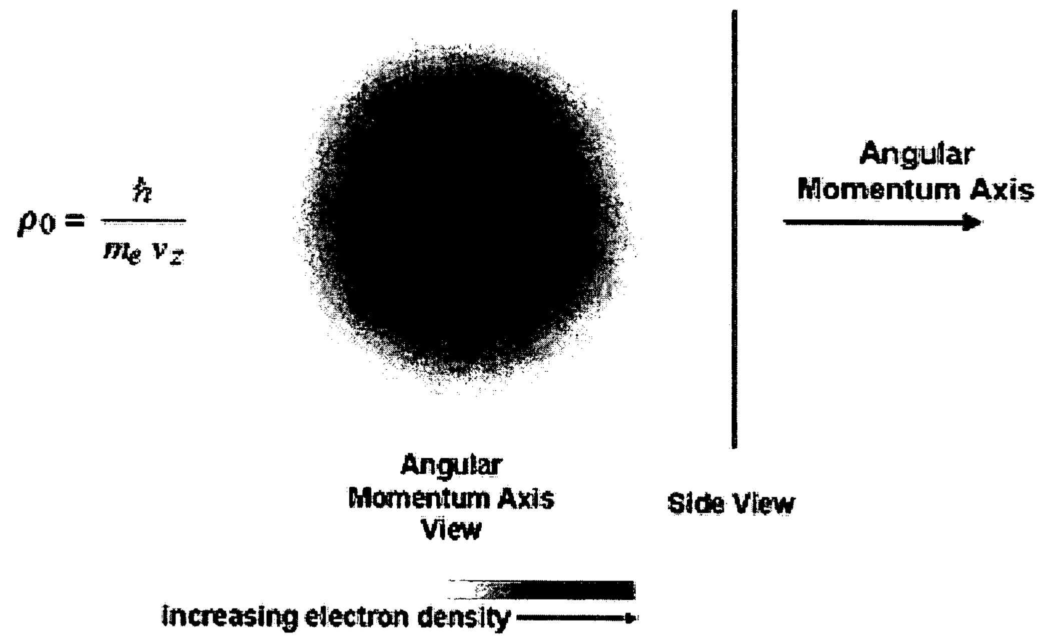


Figure. 3.1A. The angular-momentum-axis view of the magnitude of the continuous

mass (charge)-density function in the xy-plane of a polarized free electron propagating along the z-axis and the side view of this electron. For the polarized electron, the angular momentum axis is aligned along the direction of propagation, the z-axis.

The Free Electron



Animation and supporting visual aids are given at the following web site: http://www.blacklightpower.com/theory/theory.shtml

Section 63

Examiner Souw further argues on page 18 of his Appendix:

(d) On pg.39, applicant presents new arguments that the Examiner takes issue with as follows:

(1) Applicant's analysis based on Haus theorem is mathematically and physically flawed, as already addressed in the previous Souw Appendix, to be again

repeated and emphasized in the following sections (i.e., mathematically, regarding Applicant's "solution" of electron wave function p(r,t) based on the ä-function that does not satisfy the wave equation; and physically, the non-applicability of Lorentz contraction formula to Applicant's orbiting electron).

The Examiner is stuck in his myopic view according to SQM that the electron must move in the radial direction and be a solution of the three-dimensional wave equation plus time. There is no a priori reason for this to be the case. If fact, it can't be. Since the electron is bound in an inverse-squared central field, any radial motion must result in a change in the angular momentum and the total energy of the electron. Since the total energy is constant (13.6 eV), this can not be the case. The radial Dirac delta function corresponds to the two-dimensional wave equation plus time. This wave equation gives the correct physics of constant energy and angular momentum and provides for the stability of the bound electron to radiation in accordance with Maxwell's equations. See, for example:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One-Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.

5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

As given in many instances, such as the Introduction of Mills GUT (Ref. #1):

CQM APPROACH TO THE SOLUTION OF THE ELECTRON

CQM solves the electron by a different approach than that used to solve the Schrödinger wave equation. Rather than using a postulated wave equation with time eliminated in terms of the energy of the electron in a Coulomb field and solving the charge wave (Schrödinger interpretation) or the probability wave (Born interpretation), the solution for the scalar (charge) and vector potential (current) functions of the electron are sought based on first principles. CQM first assumes that the functions that physically describe the mass and charge of the electron in space and time obey the wave equation since it conserves energy and angular momentum. The solution is initially generalized to be three dimensional plus time. Rather than use the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on the experimental observation that the moving charge must not radiate. Application of the Haus' condition based on Maxwell's equations to a generalized three dimension plus time wave equation requires that the functions must be solutions of Eq. (I.16), a two dimensional wave equation plus time. This is consistent with first principle laws and ultimately matches experimentation. However, it is unconventional.

The two dimensional wave equation plus time is given by McQuarrie [2]. It is mathematically identical to the familiar rigid rotor equation of QM. The electron is confined to two dimensions (θ and ϕ) plus time, and the corresponding wave equation solution is called an electron orbitsphere. Spherical harmonic functions and time harmonic functions are well known solutions of the angular and time components of the two dimensional wave equation plus time, respectively. The solutions appear in McQuarrie [3]. A constant current function is also a solution of the wave equation. A constant function corresponding to the electron spin function is added to each of the spherical harmonic functions to give the

charge (mass)-density functions of the electron as a function of time. The integral of a spherical harmonic function over the orbitsphere is zero. The integral of the constant function over the orbitsphere is the total charge (mass) of the electron. These functions comprise the well known s, p, d, f, etc. electrons or orbitals. In the case that such an electron state arises as an excited state by photon absorption, it is radiative due to a radial dipole term in its current-density function since it possesses spacetime Fourier components synchronous with waves traveling at the speed of light as shown in the Instability of the Excited States section.

The excited states are solved including the radii of the orbitspheres using Maxwell's equations with the traditional source current boundary constraints at the electron. Quantization arises from the equation of the photon and the electron—not from the solution of the electron alone. After all, each solution models an excited state created by the absorption of a photon. The solutions are analogous to those of excited resonator modes except that the cavity is dynamic. The field lines from the proton end on the current-density function of the electron, and the electric field is zero for $r > r_n$. The trapped photons are a solution of the three dimensional wave equation plus time given by Maxwell's equations. The electrodynamic field of the photon is a constant function plus a time and spherical harmonic function that is in phase with source currents at the electron which is given by a constant plus a time and spherical harmonic function. Only particular solutions are possible as resonant photons of the electron which is a dynamic resonator cavity. The results are in agreement with first principle physics and experimental observations of the hydrogen atom, excited states, free electron, and free space photon including the wave particle duality aspects.

SPIN AND ORBITAL PARAMETERS ARISE FROM FIRST PRINCIPLES

An electron is a spinning, two-dimensional spherical surface, called an *electron orbitsphere*, that can exist in a bound state only at specific radii r_n from the nucleus. (See Figure 1.1 for a pictorial representation of an orbitsphere.) The result for the $n = 1$ state of hydrogen is that the charge-density function remains constant with each point on the surface moving at the same angular and linear velocity. The constant function solution of the two dimensional wave equation corresponds to the spin function which has a corresponding spin angular momentum that may be calculated from $\mathbf{r} \times \mathbf{p}$ applied directly to the current-density function that describes the electron. The radius of the nonradiative ($n = 1$) state is solved using the electromagnetic force equations of Maxwell relating the

charge and mass-density functions wherein the angular momentum of the electron is $\hbar$ (Eq. (1.165)). The reduced mass arises naturally from an electrodynamic interaction between the electron and the proton rather than from a point mass revolving around a point nucleus in the case of Schrödinger wave equation solutions which presents an internal inconsistency since the wave functions are spherically symmetrical.

CQM gives closed form solutions for the resonant photons and excited state electron functions. The free space photon also comprises a radial Dirac delta function, and the angular momentum of the photon given by $\mathbf{m} = \int \frac{1}{8\pi c} \mathrm{Re}[\mathbf{r} \times (\mathbf{E} \times \mathbf{B}^*)] dx^4 = \hbar$ in the Photon section is conserved for the solutions for the resonant photons and excited state electron functions. It can be demonstrated that the resonance condition between these frequencies is to be satisfied in order to have a net change of the energy field [4]. In the present case, the correspondence principle holds. That is the change in angular frequency of the electron is equal to the angular frequency of the resonant photon that excites the resonator cavity mode corresponding to the transition, and the energy is given by Planck's equation. The predicted energies, Lamb shift, fine structure splitting, hyperfine structure, resonant line shape, line width, selection rules, etc. are in agreement with observation.

The radii of excited states are solved using the electromagnetic force equations of Maxwell relating the field from the charge of the proton, the electric field of the photon, and charge and mass-density functions of the electron wherein the angular momentum of the electron is $\hbar$ (Eq. (1.165)).

For excited states of the hydrogen atom, the constant function solution of the two dimensional wave equation corresponds to the spin function. Each spherical harmonic function modulates the constant spin function and corresponds to an orbital function of a specific excited state with a corresponding phase-matched trapped photon and orbital angular momentum. Thus, the spherical harmonic function behaves as a charge-density wave which travels time harmonically on the surface of the orbitsphere about a specific axis. (See Figure 1.2 for a pictorial representation.) The amplitude of the corresponding orbital energy may be calculated from Maxwell's equations. Since the constant function is modulated harmonically, the time average of the orbital energy is zero except in the presence of a magnetic field. Nondegeneracy of energy levels arises from spin, orbital, and spin-orbital coupling interactions with

the applied field. The electrodynamic interaction with the magnetic field gives rise to the observed hyperfine splitting of the hydrogen spectrum.

Many inconsistencies arise in the case of the corresponding solutions of the Schrödinger wave equation. For example, where is the photon in excited states given by the Schrödinger equation? And, a paradox arises for the change in angular momentum due to photon absorption. The Schrödinger equation solutions for the kinetic energy of rotation K_{rot} is given by Eq. (10) of ref. [5] and the value of the electron angular momentum L for the state $Y_{lm}(\theta,\phi)$ is given by Eq. (11) of ref. [5]. They predict that the excited state rotational energy levels are nondegenerate as a function of the ℓ quantum number even in the absence of an applied magnetic field, and the predicted energy is over six orders of magnitude of the observed nondegenerate energy in the presence of a magnetic field. In the absence of a magnetic field, no preferred direction exists. In this case, the ℓ quantum number is a function of the orientation of the atom with respect to an arbitrary coordinate system. Therefore, the nondegeneracy is nonsensical and violates conservation of angular momentum of the photon.

In quantum mechanics, the spin angular momentum of the electron is called the "intrinsic angular momentum" since no physical interpretation exists. The Schrödinger equation is not Lorentzian invariant in violation of special relativity. It fails to predict the results of the Stern-Gerlach experiment which indicates the need for an additional quantum number. Quantum Electrodynamics (QED) was proposed by Dirac in 1926 to provide a generalization of quantum mechanics for high energies in conformity with the theory of special relativity and to provide a consistent treatment of the interaction of matter with radiation. It is fatally flawed. From Weisskopf [6], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; 1.) DOES NOT EXPLAIN NONRADIATION OF BOUND ELECTRONS; 2.) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite (the Schrödinger equation fails to predict the classical electron radius); 3.) it admits solutions of negative rest mass and negative kinetic energy; 4.) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; 5.) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise. Dirac's equation which was postulated to explain spin relies on the unfounded

notions of negative energy states of the vacuum, virtual particles, and gamma factors. All of these features are untenable or are inconsistent with observation. These problems regarding spin and orbital angular momentum and energies and the classical electron radius are nonexistent with CQM solutions.

Furthermore, the mathematical relationship whereby the Schrödinger equation may be transformed into a form consistent with first principles is shown *infra*. In the case that the potential energy of the Hamiltonian, H, is a constant times the wavenumber, the Schrödinger equation is the well known Bessel equation. Then one of the solutions for the wavefunction Ψ (a current-density function rather than a probability wave) is equivalent to an inverse Fourier transform. According to the duality and scale change properties of Fourier transforms, the energy equation of CQM and that of quantum mechanics are identical, the energy of a radial Dirac delta function of radius equal to an integer multiple of the radius of the hydrogen atom.

CLASSICAL QUANTUM THEORY

One-electron atoms include the hydrogen atom, He^{+}, Li^{2+}, Be^{3+}, and so on. The mass-energy and angular momentum of the electron are constant; this requires that the equation of motion of the electron be temporally and spatially harmonic. Thus, the classical wave equation applies and

$$\left[\nabla^2 - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]\rho(r,\theta,\phi,t) = 0 \tag{I.2}$$

where $\rho(r,\theta,\phi,t)$ is the charge-density function of the electron in time and space. In general, the wave equation has an infinite number of solutions. To arrive at the solution which represents the electron, a suitable boundary condition must be imposed. It is well known from experiments that each single atomic electron of a given isotope radiates to the same stable state. Thus, CQM uses the physical boundary condition of nonradiation of the bound electron to be imposed on the solution of the wave equation for the charge-density function of the electron. The condition for radiation by a moving point charge given by Haus [7] is that its spacetime Fourier transform possesses components that are synchronous with waves traveling at the speed of light. Conversely, it is proposed that the condition for nonradiation by an ensemble of moving point charges that comprises a charge-density function is

For non-radiative states, the current-density function must NOT possess spacetime Fourier components that are synchronous with waves traveling at the speed of light.

The Haus derivation applies to a moving charge-density function as well because charge obeys superposition. The Haus derivation is summarized below.

The Fourier components of the current produced by the moving charge are derived. The electric field is found from the vector equation in Fourier space ($\mathbf{k}$, ω-space). The inverse Fourier transform is carried over the magnitude of $\mathbf{k}$. The resulting expression demonstrates that the radiation field is proportional to $\mathbf{J}_\perp(\frac{\omega}{c}\mathbf{n},\omega)$, where $\mathbf{J}_\perp(\mathbf{k},\omega)$ is the spacetime Fourier transform of the current perpendicular to $\mathbf{k}$ and $\mathbf{n} \equiv \frac{\mathbf{k}}{|k|}$. Specifically,

$$\mathbf{E}_\perp(\mathbf{r},\omega)\frac{d\omega}{2\pi} = \frac{c}{2\pi}\int \rho(\omega,\Omega) d\omega d\Omega \sqrt{\frac{\mu_0}{\varepsilon_0}}\mathbf{n}\,X\left(\mathbf{n}\,X\mathbf{J}_\perp\left(\frac{\omega}{c}\mathbf{n},\omega\right)e^{i\left(\frac{\omega}{c}\right)\mathbf{n}\bullet\mathbf{r}}\right) \quad (1.3)$$

The field $\mathbf{E}_\perp(\mathbf{r},\omega)\frac{d\omega}{2\pi}$ is proportional to $\mathbf{J}_\perp\left(\frac{\omega}{c}\mathbf{n},\omega\right)$, namely, the Fourier component for which $\mathbf{k} = \frac{\omega}{c}$. Factors of ω that multiply the Fourier component of the current are due to the density of modes per unit volume and unit solid angle. An unaccelerated charge does not radiate in free space, not because it experiences no acceleration, but because it has no Fourier component $\mathbf{J}_\perp\left(\frac{\omega}{c}\mathbf{n},\omega\right)$. (Nonradiation is also shown directly using Maxwell's equations in Appendix I: Nonradiation Based on the Electromagnetic Fields and the Poynting Power Vector.)

The time, radial, and angular solutions of the wave equation are separable. The motion is time harmonic with frequency ω_n. To be a harmonic solution of the wave equation in spherical coordinates, the angular functions must be spherical harmonic functions. A zero of the spacetime Fourier transform of the product function of two spherical harmonic angular functions, a time harmonic function, and an unknown radial function is sought. The solution for the radial function which satisfies the boundary condition is a delta function

$$f(r) = \frac{1}{r^2}\delta(r - r_n) \quad (1.4)$$

where $r_n = nr_1$ is an allowed radius. Thus, bound electrons are described by a charge-density (mass-density) function which is the product of a radial delta function ($f(r) = \frac{1}{r^2}\delta(r - r_n)$), two angular functions (spherical harmonic functions), and a time harmonic function. Thus, an electron is a spinning, two-dimensional spherical surface, called an *electron orbitsphere*, that can exist in a bound state at only specified distances from the nucleus as shown in Figure 1.1. More explicitly, the orbitsphere comprises a two-dimensional spherical shell of moving charge.

The total function that describes the spinning motion of each electron orbitsphere is composed of two functions. One function, the spin function, is spatially uniform over the orbitsphere, spins with a quantized angular velocity, and gives rise to spin angular momentum. The other function, the modulation function, can be spatially uniform—in which case there is no orbital angular momentum and the magnetic moment of the electron orbitsphere is one Bohr magneton—or not spatially uniform—in which case there is orbital angular momentum. The modulation function also rotates with a quantized angular velocity.

The uniform current density function $Y_0^{\,0}(\phi,\theta)$, the orbitsphere equation of motion of the electron (Eqs. (1.64-1.65)), corresponding to the constant charge function of the orbitsphere that gives rise to the spin of the electron is generated from a basis set current-vector field defined as the orbitsphere current-vector field ("orbitsphere-cvf"). This in turn is generated from orthogonal great circle current loops that serve as basis elements. In Appendix III, the *continuous* uniform electron current density function $Y_0^{\,0}(\phi,\theta)$ (Eqs. (1.64-1.65)) is then exactly generated from this orbitsphere-cvf as a basis element by a convolution operator comprising an autocorrelation-type function.

The orbitsphere-cvf comprises an infinite series of correlated orthogonal great circle current loops. The current pattern is generated over the surface by two sets of an infinite series of nested rotations of two orthogonal great circle current loops where the coordinate axes rotate with the two orthogonal great circles. Each infinitesimal rotation of the infinite series is about the new i'-axis and new j'-axis which results from the preceding such rotation. For each of the two sets of nested rotations, the angular sum of the rotations about each rotating i'-axis and j'-axis totals $\frac{\sqrt{2}}{2}\pi$ radians.

Consider the electron to be evenly distributed within two sets of orthogonal great circle current loops for Steps One and Two. Then,

consider two infinitesimal point mass (charge)-density elements, one and two, of one set of two orthogonal great circle current loops wherein initially the first current loop lies in the yz-plane, and the second current loop lies in the xz-plane. The xyz Cartesian coordinate frame is designated the laboratory reference frame. The algorithm to generate the orbitsphere-cvf rotates the great circles and the corresponding coordinates relative to the xyz frame. A primed Cartesian coordinate system refers to the axes that rotate with the great circles and determines the basis-set reference frame. Each element of the current pattern is obtained with each conjugate set of rotations. For Step One, consider two such infinitesimal charges (masses) at points one (moving counter clockwise on the great circle in the y'z'-plane) and two (moving clockwise on the great circle in the x'z'-plane) of two orthogonal great circle current loops in the basis frame are considered as sub-basis elements to generate the current density corresponding to the spin quantum number, $s=\frac{1}{2}$; $m_s=\pm\frac{1}{2}$. Initially element one is at $x'=0$, $y'=0$, and $z'=r_n$ and element two is at $x'=r_n$, $y'=0$, and $z'=0$ as shown in Figure 1.4A. The equations of motion, in the sub-basis-set reference frame are given by

point one:

$$x_1^{'}=0 \qquad y_1^{'}=-r_n\sin(\omega_n t) \qquad z_1^{'}=r_n\cos(\omega_n t) \tag{1.5a}$$

point two:

$$x_2^{'}=r_n\cos(\omega_n t) \qquad y_2^{'}=0 \qquad z_2^{'}=r_n\sin(\omega_n t) \tag{1.5b}$$

For Step Two, consider two charge (mass)-density elements, point one and two, in the basis-set reference frame at time zero. Element one is at $x'=0$, $y'=r_n$, and $z'=0$ and element two is at $x'=r_n$, $y'=0$, and $z'=0$. Let element one move clockwise on a great circle toward the -z'-axis as shown in Figure 1.4B, and let element two move counter clockwise on a great circle toward the y'-axis as shown in Figure 1.4B. The equations of motion, in the basis-set reference frame are given by

point one:

$$x_1^{'}=0 \qquad y_1^{'}=r_n\cos(\omega_n t) \qquad z_1^{'}=-r_n\sin(\omega_n t) \tag{1.6a}$$

point two:

$$x_2' = r_n \cos(\omega_n t) \qquad y_2' = r_n \sin(\omega_n t) \qquad z_2' = 0 \tag{I.6b}$$

The great circles are rotated by an infinitesimal angle $\pm\Delta\alpha_{i'}$ (a rotation around the x'-axis or z'-axis for Steps One and Two, respectively) and then by $\pm\Delta\alpha_{j'}$ (a rotation around the new y'-axis or x'-axis for Steps One and Two, respectively) where the rotation directions are shown in Figures 1.4A and 1.4B, respectively. The coordinates of each point on each rotated great circle (x',y',z') is expressed in terms of the first (x,y,z) coordinates by the following transforms where clockwise rotations are defined as positive:

Step One

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_y) & 0 & -\sin(\Delta\alpha_y) \\ 0 & 1 & 0 \\ \sin(\Delta\alpha_y) & 0 & \cos(\Delta\alpha_y) \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ 0 & -\sin(\Delta\alpha_x) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_y) & \sin(\Delta\alpha_y)\sin(\Delta\alpha_x) & -\sin(\Delta\alpha_y)\cos(\Delta\alpha_x) \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ \sin(\Delta\alpha_y) & -\cos(\Delta\alpha_y)\sin(\Delta\alpha_x) & \cos(\Delta\alpha_y)\cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

(I.7)

Step Two

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ 0 & -\sin(\Delta\alpha_x) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} \cos(\Delta\alpha_z) & \sin(\Delta\alpha_z) & 0 \\ -\sin(\Delta\alpha_z) & \cos(\Delta\alpha_z) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_z) & \sin(\Delta\alpha_z) & 0 \\ -\cos(\Delta\alpha_x)\sin(\Delta\alpha_z) & \cos(\Delta\alpha_x)\cos(\Delta\alpha_z) & \sin(\Delta\alpha_x) \\ \sin(\Delta\alpha_x)\sin(\Delta\alpha_z) & -\sin(\Delta\alpha_x)\cos(\Delta\alpha_z) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} \tag{I.8}$$

where the angular sum is $\lim_{\Delta\alpha \to 0} \sum_{n=1}^{\frac{\frac{\sqrt{2}}{2}\pi}{|\Delta\alpha_{i',j'}|}} |\Delta\alpha_{i',j'}| = \frac{\sqrt{2}}{2}\pi$.

The orbitsphere-cvf is given by n reiterations of Eqs. (I.7) and (I.8) for each point on each of the two orthogonal great circles during each of Steps One and Two where the sign of $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ for each Step are given in Table 1.1. The output given by the non-primed coordinates is the input of the next iteration corresponding to each successive nested rotation by the infinitesimal angle $\pm\Delta\alpha_{i'}$ or $\pm\Delta\alpha_{j'}$ where the magnitude of the angular sum of the n rotations about each of the i'-axis and the j'-axis is $\frac{\sqrt{2}}{2}\pi$. Half of the orbitsphere-cvf is generated during each of Steps One and Two.

Following Step Two, in order to match the boundary condition that the magnitude of the velocity at any given point on the surface is given by Eq. (1.56), the output half of the orbitsphere-cvf is rotated clockwise by an angle of $\frac{\pi}{4}$ about the z-axis. Using Eq. (I.8) with $\Delta\alpha_{z'} = \frac{\pi}{4}$ and $\Delta\alpha_{x'} = 0$ gives the rotation. Then, the one half of the orbitsphere-cvf generated from Step One is superimposed with the complementary half obtained

from Step Two following its rotation about the z-axis of $\frac{\pi}{4}$ to give the orbitsphere-cvf.

The current pattern of the orbitsphere-cvf generated by the nested rotations of the orthogonal great circle current loops is a continuous and total coverage of the spherical surface, but it is shown as visual representations using 6 degree increments of the infinitesimal angular variable $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ of Eqs. (I.7) and (I.8) from six perspectives in Figures 1.5A-F. In each case, the complete orbitsphere-cvf current pattern corresponds to all the correlated points, points one and two, of the orthogonal great circles shown in Figures 1.4A and 1.4B which are rotated according to Eqs. (I.7) and (I.8) where $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ approach zero and the summation of the infinitesimal angular rotations of $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ about the successive i'-axes and j'-axes is $\frac{\sqrt{2}}{2}\pi$ for each Step. The current pattern gives rise to the phenomenon corresponding to the spin quantum number.

The resultant angular momentum projections of $\mathbf{L}_{xy} = \frac{\hbar}{4}$ and $\mathbf{L}_z = \frac{\hbar}{2}$ meet the boundary condition for the unique current having an angular velocity magnitude at each point on the surface given by Eq. (1.56) and give rise to the Stern Gerlach experiment as shown in the Magnetic Parameters of the Electron (Bohr Magneton) section, and in the Electron g Factor section. The further constraint that the current density is uniform such that the charge density is uniform, corresponding to an equipotential, minimum energy surface is satisfied by using the orbitsphere-cvf as a basis element to generate $Y_0^0(\phi,\theta)$ using a convolution operator comprising an autocorrelation-type function as given in Appendix III. The operator comprises the convolution of each great circle current loop of the orbitsphere-cvf designated as the primary orbitsphere-cvf with a second orbitsphere-cvf designated as the secondary orbitsphere-cvf.

The orbitsphere-cvf comprises two components corresponding to each of STEP ONE and STEP TWO. As shown for STEP TWO, the angular momentum vector is stationary on the $\left(-\frac{1}{\sqrt{2}}\mathbf{i}_x, \frac{1}{\sqrt{2}}\mathbf{i}_y, \mathbf{i}_z\right)$-axis as the component orbitsphere-cvf is generated by the series of nested rotations using Eq. (1.70b). It is shown in Appendix III that STEP TWO can also be generated by a 2π-rotation of a single basis-element current loop about

the $\left(-\frac{1}{\sqrt{2}}\mathbf{i}_x, \frac{1}{\sqrt{2}}\mathbf{i}_y, \mathbf{i}_z\right)$-axis. In the general case that the resultant angular momentum of each pair of orthogonal great circle current loops of the component orbitsphere-cvf is along the 2π-rotational axis (defined as the rotational axis which generates the component orbitsphere-cvf from a basis-element great circle), a secondary nth component orbitsphere-cvf can serve as a basis element to match the angular momentum of any given nth great circle of a primary component orbitsphere-cvf. The replacement of each great circle of the primary orbitsphere-cvf with a secondary orbitsphere-cvf of matching angular momentum, orientation, and phase comprises an autocorrelation-type function that exactly gives rise to the spherically-symmetric current density, $Y_0^0(\phi,\theta)$, as the sum of two uniform spherical contributions from each component. The resulting exact uniform current distribution obtained from the convolution has the same angular momentum distribution, resultant, $\mathbf{L}_\mathbf{R}$, and components of $\mathbf{L}_{xy} = \frac{\hbar}{4}$ and $\mathbf{L}_z = \frac{\hbar}{2}$ as those of the orbitsphere-cvf used as a primary basis element.

In contrast to the QM and QED cases (See Appendix II: Quantum Electrodynamics is Purely Mathematical and Has No Basis in Reality), the fourth quantum number arises naturally in CQM as derived in the Electron g Factor section. The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s ($s = \frac{1}{2}$; $m_s = \pm\frac{1}{2}$). Conservation of angular momentum of the orbitsphere permits a discrete change of its "kinetic angular momentum" ($\mathbf{r} \times m\mathbf{v}$) with respect to the field of $\frac{\hbar}{2}$, and concomitantly the "potential angular momentum" ($\mathbf{r} \times e\mathbf{A}$) must change by $-\frac{\hbar}{2}$. The flux change, ϕ, of the orbitsphere for $r < r_n$ is determined as follows:

$$\Delta\mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \tag{I.9}$$

$$= \left[\frac{\hbar}{2} - \frac{e2\pi rA}{2\pi}\right]\hat{z} \tag{I.10}$$

$$= \left[\frac{\hbar}{2} - \frac{e\phi}{2\pi}\right]\hat{z} \tag{I.11}$$

In order that the change of angular momentum, $\Delta\mathbf{L}$, equals zero, ϕ must be $\Phi_0 = \frac{h}{2e}$, the magnetic flux quantum. Thus, to conserve angular momentum in the presence of an applied magnetic field, the orbitsphere magnetic moment can be parallel or antiparallel to an applied field as observed with the Stern-Gerlach experiment, and the flip between orientations is accompanied by the "capture" of the magnetic flux quantum by the orbitsphere. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla \bullet (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right] - \frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right] - \mathbf{J} \bullet \mathbf{E} \tag{I.12}$$

Eq. (I.13) derived in the Electron g Factor section gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively.

$$\Delta E_{mag}^{spin} = 2\left(1 + \frac{\alpha}{2\pi} + \frac{2}{3}\alpha^2\left(\frac{\alpha}{2\pi}\right) - \frac{4}{3}\left(\frac{\alpha}{2\pi}\right)^2\right)\mu_B B \tag{I.13}$$

$$\Delta E_{mag}^{spin} = g\mu_B B \tag{I.14}$$

The spin-flip transition can be considered as involving a magnetic moment of g times that of a Bohr magneton. The g factor is redesignated the fluxon g factor as opposed to the anomalous g factor. The calculated value of $\frac{g}{2}$ is $1.001\ 159\ 652\ 137$. The experimental value [8] of $\frac{g}{2}$ is $1.001\ 159\ 652\ 188(4)$.

CQM solves the wave equation for the charge-density function of the electron. The time, radial, and angular solutions of the wave equation are separable. Also, the radial function for the electron indicates that the electron is two-dimensional. Therefore, the angular mass-density function of the electron, $A(\theta,\phi,t)$, must be a solution of the wave equation in two dimensions (plus time). EQ. (I.2) becomes

$$\left[\nabla^2 - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]A(\theta,\phi,t) = 0 \tag{I.15}$$

where $\rho(r,\theta,\phi,t) = f(r)A(\theta,\phi,t) = \frac{1}{r^2}\delta(r - r_n)A(\theta,\phi,t)$ and $A(\theta,\phi,t) = Y(\theta,\phi)k(t)$. Specifically, the wave equation is

$$\left[\frac{1}{r^2 \sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right)_{r,\phi} + \frac{1}{r^2\sin^2\theta}\left(\frac{\partial^2}{\partial\phi^2}\right)_{r,\theta} - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]A(\theta,\phi,t) = 0 \tag{I.16}$$

where v is the linear velocity of the electron. The charge-density functions including the time-function factor are

$\ell = 0$

$$\rho(r,\theta,\phi,t) = \frac{e}{8\pi r^2}[\delta(r-r_n)]\left[Y_0^0(\theta,\phi) + Y_\ell^m(\theta,\phi)\right] \quad (I.17)$$

$\ell \neq 0$

$$\rho(r,\theta,\phi,t) = \frac{e}{4\pi r^2}[\delta(r-r_n)]\left[Y_0^0(\theta,\phi) + \mathrm{Re}\left\{Y_\ell^m(\theta,\phi)e^{i\omega_n t}\right\}\right] \quad (I.18)$$

where $\mathrm{Re}\left\{Y_\ell^m(\theta,\phi)e^{i\omega_n t}\right\} = P_\ell^m(\cos\theta)\cos(m\phi + \omega_n' t)$ and to keep the form of the spherical harmonic as a traveling wave about the z-axis, $\omega_n' = m\omega_n$.

The spin function of the electron (see Figure 1.1 for the charge function and Figure 1.5A for the current function) corresponds to the nonradiative $n=1$, $\ell = 0$ state of atomic hydrogen which is well known as an s state or orbital. The constant spin function is modulated by a time and spherical harmonic function as given by Eq. (I.18) and shown in Figure 1.2. The modulation or traveling charge-density wave corresponds to an orbital angular momentum in addition to a spin angular momentum. These states are typically referred to as p, d, f, etc. orbitals and correspond to an ℓ quantum number not equal to zero. Application of the condition from Haus [7] (Eqs, (I.19-I.21)) also predicts nonradiation for a constant spin function modulated by a time and spherically harmonic orbital function. There is acceleration without radiation. (Also see Abbott and Griffiths and Goedecke [9-10]). Nonradiation is also shown directly using Maxwell's equations in Appendix I: Nonradiation Based on the Electromagnetic Fields and the Poynting Power Vector. However, in the case that such a state arises as an excited state by photon absorption, it is radiative due to a radial dipole term in its current-density function since it possesses spacetime Fourier transform components synchronous with waves traveling at the speed of light as shown in the Instability of Excited States section.

The Fourier transform of the electron charge-density function is a solution of the four-dimensional wave equation in frequency space (**k**, ω-space). Then the corresponding Fourier transform of the current-density function $K(s,\Theta,\Phi,\omega)$ is given by multiplying by the constant angular frequency.

$$K(s,\Theta,\Phi,\omega)=4\pi\omega_n\frac{\sin(2s_nr_n)}{2s_nr_n}\otimes 2\pi\sum_{\upsilon=1}^{\infty}\frac{(-1)^{\upsilon-1}(\pi\sin\Theta)^{2(\upsilon-1)}}{(\upsilon-1)!(\upsilon-1)!}\frac{\Gamma\left(\frac{1}{2}\right)\Gamma\left(\upsilon+\frac{1}{2}\right)}{(\pi\cos\Theta)^{2\upsilon+1}2^{\upsilon+1}}\frac{2\upsilon!}{(\upsilon-1)!}s^{-2\upsilon}$$
$$\otimes 2\pi\sum_{\upsilon=1}^{\infty}\frac{(-1)^{\upsilon-1}(\pi\sin\Phi)^{2(\upsilon-1)}}{(\upsilon-1)!(\upsilon-1)!}\frac{\Gamma\left(\frac{1}{2}\right)\Gamma\left(\upsilon+\frac{1}{2}\right)}{(\pi\cos\Phi)^{2\upsilon+1}2^{\upsilon+1}}\frac{2\upsilon!}{(\upsilon-1)!}s^{-2\upsilon}\frac{1}{4\pi}[\delta(\omega-\omega_n)+\delta(\omega+\omega_n)]$$

(I.19)

The motion on the orbitsphere is angular; however, a radial component exists due to special relativistic effects. Consider the radial wave vector of the sinc function. When the radial projection of the velocity is c

$$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n \qquad \text{(I.20)}$$

the relativistically corrected wavelength is

$$r_n = \lambda_n \qquad \text{(I.21)}$$

(i.e. the lab frame motion in the angular direction goes to zero as the velocity approaches the speed of light). Substitution of Eq. (I.21) into the sinc function results in the vanishing of the entire Fourier transform of the current-density function. Thus, spacetime harmonics of $\frac{\omega_n}{c}=k$ or $\frac{\omega_n}{c}\sqrt{\frac{\varepsilon}{\varepsilon_o}}=k$ for which the Fourier transform of the current-density function is nonzero do not exist. Radiation due to charge motion does not occur in any medium when this boundary condition is met.

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Section 64

Examiner Souw further demonstrates a disturbing lack of understanding of Applicant's disclosed invention with his statements on pages 18-19 of the Appendix that:

> (2) Applicant's allegation that QM is inconsistent with experimental observation is doubly flawed. Firstly, the fact that hydrogen ground state (n=1) does not radiate is confirmed by experimental observations without a single exception, as already recited in the previous Appendix. Secondly, Applicant's insistence that the n=1 state *does radiate* is not supported by any valid experimental evidence. Applicant's own "experimental evidence" (if any) must be disqualified, because it can not be confirmed by any independent third party researcher.

Applicant agrees with the Examiner's statement that "the fact that hydrogen ground state (n=1) does not radiate is confirmed by experimental observations without a single exception". Applicant uses this as the basis to solve the hydrogen atom rather than using a purely mathematical boundary condition as in the case of SQM, as discussed in Section 63 above.

Applicant, however, does not agree with the Examiner's further statement regarding "Applicant's insistence that the n=1 state *does radiate*." That statement proves that the Examiner does not have even a basic understanding of Applicant's

disclosed invention. The patent specification, Applicant's 112 publications, as well as some of the papers from the section entitled "Independent Test Results" disclose the resonant, **nonradiative** energy transfer from the hydrogen atom to the catalyst. For example, from:

67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.

The elimination of known explanations indicate a new result. Since the novel peaks were only observed with helium and hydrogen present, new hydrogen, helium, or helium-hydrogen species are possibilities. It is well known that empirically the excited energy states of atomic hydrogen are given by Rydberg equation (Eq. (2a) for $n > 1$ in Eq. (2b)).

$$E_n = -\frac{e^2}{n^2 8\pi\varepsilon_o a_H} = -\frac{13.598\ eV}{n^2} \tag{2a}$$

$$n = 1,2,3,\ldots \tag{2b}$$

The $n = 1$ state is the "ground" state for "pure" photon transitions (i.e. the $n = 1$ state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state may be possible by a resonant nonradiative energy transfer such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common [47]. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling [48].

We propose that atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as He^+ which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2\ eV$ wherein m is an integer. The theory was given previously [49]. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \ldots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \tag{2c}$$

replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. Thus, the Rydberg states are extended to lower levels as depicted in Figure 9. The $n = 1$ state of hydrogen and the

$n = \frac{1}{\text{integer}}$ states of hydrogen are nonradiative, but a transition between two nonradiative states is possible via a nonradiative energy transfer, say $n=1$ to $n=1/2$. Thus, a catalyst provides a net positive enthalpy of reaction of $m \cdot 27.2\ eV$ (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (2a) and (2c).

The novel peaks fit two empirical relationships. In order of energy, the set comprising the peaks at $91.2\ nm$, $45.6\ nm$, $30.4\ nm$, $13.03\ nm$, $10.13\ nm$, and $8.29\ nm$ correspond to energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,7,9,11$. In order of energy, the set comprising the peaks at $37.4\ nm$, $20.5\ nm$, and $14.15\ nm$ correspond to energies of $q \cdot 13.6 - 21.21\ eV$ where $q = 4,6,8$. These lines can be explained as electronic transitions to fractional Rydberg states of atomic hydrogen given by Eqs. (2a) and (2c) wherein the catalytic system involves helium ions because the second ionization energy of helium is $54.417\ eV$, which is equivalent to $2 \cdot 27.2\ eV$. In this case, $54.417\ eV$ is transferred nonradiatively from atomic hydrogen to He^+ which is resonantly ionized. The electron decays to the $n = 1/3$ state with the further release of $54.417\ eV$ which may be emitted as a photon. The catalysis reaction is

$$54.417\ eV + He^+ + H[a_H] \rightarrow He^{2+} + e^- + H\left[\frac{a_H}{3}\right] + 108.8\ eV \quad (3)$$

$$He^{2+} + e^- \rightarrow He^+ + 54.417\ eV \quad (4)$$

And, the overall reaction is

$$H[a_H] \rightarrow H\left[\frac{a_H}{3}\right] + 54.4\ eV + 54.4\ eV \quad (5)$$

Since the products of the catalysis reaction have binding energies of $m \cdot 27.2\ eV$, they may further serve as catalysts. Thus, further catalytic transitions may occur: $n = \frac{1}{3} \rightarrow \frac{1}{4}$, $\frac{1}{4} \rightarrow \frac{1}{5}$, and so on.

Electronic transitions to Rydberg states given by Eqs. (2a) and (2c) catalyzed by the resonant nonradiative transfer of $m \cdot 27.2\ eV$ would give rise to a series of emission lines of energies $q \cdot 13.6\ eV$ where q is an integer. It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. That is, the catalytic reaction

$$H[a_H] \xrightarrow{He^+} H\left[\frac{a_H}{3}\right] + 54.4\ eV + 54.4\ eV \qquad (6)$$

yields $54.4\ eV$ by Eq. (4) and a photon of $54.4\ eV$ ($22.8\ nm$). Once emitted, the photon may be absorbed or scattered. When this photon strikes $He\ (1s^2)$, $21.2\ eV$ may be absorbed in the excitation to $He\ (1s^1 2p^1)$. This leaves a $33.19\ eV$ ($37.4\ nm$) photon peak and a $21.21\ eV$ ($58.4\ nm$) photon from $He\ (1s^1 2p^1)$. Thus, for helium the inelastic scattered peak of $54.4\ eV$ photons from Eq. (3) is given by

$$E = 54.4\ eV - 21.21\ eV = 33.19\ eV\ (37.4\ nm) \qquad (7)$$

A novel peak shown in Figures 2-4 was observed at $37.4\ nm$. Furthermore, the intensity of the $58.4\ nm$ peak corresponding to the spectra shown in Figure 4 was about 60,000 photons/sec. Thus, the transition $He\ (1s^2) \rightarrow He\ (1s^1 2p^1)$ dominated the inelastic scattering of EUV peaks. The general reaction is

$$photon\ (h\nu) + He\ (1s^2) \rightarrow He\ (1s^1 2p^1) + photon\ (h\nu - 21.21\ eV) \qquad (8)$$

The two empirical series may be combined—one directly from Eqs. (2a, 2c) and the other indirectly with Eq. (8). The energies for the novel lines in order of energy are $13.6\ eV$, $27.2\ eV$, $40.8\ eV$, $54.4\ eV$, $81.6\ eV$, $95.2\ eV$, $108.8\ eV$, $122.4\ eV$ and $149.6\ eV$. The corresponding peaks are $91.2\ nm$, $45.6\ nm$, $30.4\ nm$, $37.4\ nm$, $20.5\ nm$, $13.03\ nm$, $14.15\ nm$, $10.13\ nm$, and $8.29\ nm$, respectively. Thus, the identified novel lines correspond to energies of $q \cdot 13.6\ eV$, $q = 1,2,3,7,9,11.$ or $q \cdot 13.6\ eV$, $q = 4,6,8$ less $21.2\ eV$ corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He\ (1s^2)$ to $He\ (1s^1 2p^1)$. The values of q observed are consistent with those expected based on Eq. (5) and the subsequent autocatalyzed reactions as discussed previously [50]. The broad satellite peak at $44.2\ nm$ show in Figure 2-4 is consistent with the reaction mechanism of a nonradiative transfer to a catalyst followed by emission. There is remarkable agreement between the data and the proposed transitions to fractional Rydberg states and these lines inelastically scattered by helium according to Eq. (8). All other peaks could be assigned to He I, He II, second order lines, or atomic or molecular hydrogen emission. No known lines of helium or hydrogen explain the $q \cdot 13.6\ eV$ related set of peaks.

The above data disqualifies the Examiner's further statement regarding lack of support by "any valid experimental evidence." The body of evidence that experimentally confirms hydrino is overwhelming and has been extensively validated as given in the Experimental sections of this Response.

Section 65

Examiner Souw further asserts on page 19 of this Appendix that:

> (3) Applicant's arguments based on Laloë's article [5] are unpersuasive for reasons to be discussed in a section 6, sub-paragraph (d) below.

It is the Examiners arguments that are unpersuasive and prove that SQM is not based on physical laws. In fact, the Laloë's article demonstrates that it is hard to agree on what SQM is based on anything other than a belief system founded on postulates that gives rise to scenarios and consequences that are in contradiction with physical laws.

Section 66

On page 19 of his Appendix, Examiner Souw again improperly dismisses Applicant's scientific evidence, stating:

> (4) Reference [80] is to be disqualified, since it is written by Applicant based on his own flawed theory which has been addressed numerous times by the Examiner.

Other theoreticians, such as those at Princeton University, agree with Applicant's arguments given in [80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted] that the Heisenberg Uncertainty Principle provides no atomic stability [E. H. Lieb, "The stability of matter", Reviews of Modern Physics, Vol. 48, No. 4, (1976), pp, 553-569].

Section 67

Examiner Souw commits additional errors in his statement on page 19 of the Appendix that:

> (5) The proof given by Feynman that has removed the problem of self-radiation in an orbiting electron by virtue of the Heisenberg Uncertainty Principle (HUP) is scientifically convincing and well-accepted by the scientific community, while having been also independently confirmed based on exactly the same reason by the Examiner in the previous Appendix (same section 2, pg.2, lines 1-10; see also sect. 2.c above). This means, the scientific community generally agrees with Feynman and the Examiner, but disagrees with Applicant.

This is NOT TRUE. Lieb [34] also addresses the fact that the Schrödinger equation has been accepted for over a half of a century without addressing the stability of matter. Lieb also shows that the Feynman argument is "false" due to an inappropriate application of the Heisenberg Uncertainty Principle and admonishes the misrepresentation in textbooks. By considering a wavefunction comprised of two components at two radii such that the electron can not have both sharply defined momentum and position in accordance with the Uncertainty Principle, Lieb shows that the radius can be arbitrarily small including zero such that the energy is negative infinity. This result is obviously not predictive of stability.

Furthermore, the approach by Feynman and Lieb are physically baseless. Attempts to prove that a system has a kinetic energy that exceeds some lower bound such that the total energy is not negative infinity is not based on physics since it ignores radiation-loss terms. More recently, Bugliaro at al. [35] have attempted to use QED to prove the stability of matter with N nonrelativistic electrons and K static nuclei of nuclear charge $\leq Ze$ that can interact with photons. Here, the problem is "rigged" since the radiation field is defined to be quantized, an ultraviolet cutoff is arbitrarily imposed, Maxwell's equations are not obeyed due to the defined properties of the polarizations, and creation and annihilation operators including the limitation of the couplings of photons to electrons via Pauli operators only. Furthermore, the proof has nothing to do with the solutions of the actual atomic energy levels. Even then, stability is only found for a nuclear charge $Z \leq 6$. Thus, it is evident that neither the Schrödinger equation,

variants thereof, or QED provide a general, self consistent, rigorous, and physical basis for the stability of matter.

34. E. H. Lieb, "The stability of matter", Reviews of Modern Physics, Vol. 48, No. 4, (1976), pp, 553-569.
35. L. Bugliaro, J. Fröhlich, G. M. Graf, "Stability of quantum electrodynamics with nonrelativistic matter", Physical Review Letters, Vol. 77, No. 17, (1996), pp. 3494-3497.

Section 68

Examiner Souw adds to the list of inconsistent position he has taken with the following statements on page 19 of the Appendix:

> **3. Regarding the alleged instability of the (excited) states**
>
> Applicant does not adequately address the Examiner's refutation as recited in the previous Appendix, but keeps repeating and insisting the correctness of his Grand Unified Theory (GUT). Applicant misunderstands the QM by sticking to the viewpoint of classical physics, instead of properly reconciling both viewpoints under the correspondence principle. Applicant's misinterpretation of "stationary states" in QM has been adequately described previously.

Particularly troubling is the Examiner's statement that, "Applicant misunderstands the QM by sticking to the viewpoint of classical physics, instead of properly reconciling both viewpoints under the correspondence principle." The Examiner contradicts himself by stating the SQM is based on physical laws, then argues on the other side that Applicant's use of physical laws is not correct according to SQM. Rather, it is the correspondence principle (CP) that is incorrect. The basis of the CP is that physical laws do not apply to atomic-size objects, but SQM must be consistent with physical laws as the scale increases. Then, what applies in the transition, and on what scale? There are no answers to these questions under SQM, which demonstrates why that it is not a valid theory of nature.

The nonzero instantaneous velocity (the particle does move according to the Examiner) requires that the point electron of SQM must radiate, as discussed under sections dealing with the Feynman-instability argument.

What is even more troubling when considering the Examiner's insistence that the n=1 state is stationary, yet it is moving, is that the electron of zero volume would have to travel at infinite velocity and "know" how to cover all trajectories to perfectly cover the space of the wave function for n=1. Yet, to would have to do this in one period given by 13.6 eV/h, not radiate, maintain a constant energy and angular momentum, always have a relativistically invariant magnetic moment of a Bohr magneton, be electrically neutral, give rise to the Stern Gerlach result including the g factor (know to about 14 significant figures), wherein the g factor determination must be an identical value upon measurement at any time, etc. It is easy to appreciate that this view collapses on its absurdity.

Section 69

Examiner Souw errs yet again in making the following statement taken from pages 19-20 of the Appendix:

> As recited in the previous Appendix, Applicant's formulas (1.59) to (1.68), as well as Eq. (1) to (5) on pg.44-45, are mathematically flawed and physically incorrect, not only with regard to QM, but also with respect to (Maxwell's) electrodynamics and Einstein's relativity theory, as already described in the previous Appendix and in Sect. 10 below.

The Examiner's error is confirmed by other physicists, such as those who provided the reviews given in Section 54 above. The correctness of the equations and special relativistic theory is evident in the closed-formed equations having fundamental constants only that give 100's of predictions that match the experimental values with remarkable agreement. These results can not be matched by SQM. See:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.

106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

Abstracts of specific examples are:

102. **R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.**

It is true that the Schrödinger equation can be solved exactly for the hydrogen atom; although, it is not true that the result is the exact solution of the hydrogen atom. Electron spin is missed entirely, and there are many internal inconsistencies and nonphysical consequences that do not agree with experimental results. The Dirac equation does not reconcile this situation. Many additional shortcomings arise such as instability to radiation, negative kinetic energy states, intractable infinities, virtual particles at every point in space, the Klein paradox, violation of Einstein causality, and "spooky" action at a distance. Despite its successes, quantum mechanics (QM) has remained mysterious to all who have encountered it. Starting with Bohr and progressing into the present, the departure from intuitive, physical reality has widened. The connection between quantum mechanics and reality is more than just a

"philosophical" issue. It reveals that quantum mechanics is not a correct or complete theory of the physical world and that inescapable internal inconsistencies and incongruities arise when attempts are made to treat it as a physical as opposed to a purely mathematical "tool". Some of these issues are discussed in a review by Laloë [1]. But, QM has severe limitations even as a tool. Beyond one-electron atoms, multielectron-atom quantum mechanical equations can not be solved except by approximation methods involving adjustable-parameter theories (perturbation theory, variational methods, self-consistent field method, multi-configuration Hartree Fock method, multi-configuration parametric potential method, $1/Z$ expansion method, multi-configuration Dirac-Fock method, electron correlation terms, QED terms, etc.)—all of which contain assumptions that can not be physically tested and are not consistent with physical laws. In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified by Schrödinger, a classical approach was explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level [2-4]. Physical laws and intuition are restored when dealing with the wave equation and quantum mechanical problems. Specifically, a theory of classical quantum mechanics (CQM) was derived from first principles that successfully applies physical laws on all scales. Rather than use the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy*. The electron must be extended rather than a point. On this basis with the assumption that physical laws including Maxwell's equation apply to bound electrons, the hydrogen atom was solved exactly from first principles. The remarkable agreement across the spectrum of experimental results indicates that this is the correct model of the hydrogen atom. In this paper, the physical approach was applied to multielectron atoms that were solved exactly disproving the deep-seated view that such exact solutions can not exist according to quantum mechanics. The general solutions for one through twenty-electron atoms are given. The predictions are in remarkable agreement with the experimental values known for 400 atoms and ions.

106. **R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a**

Unique Solution for the First Time", Annales de la Foundation Louis de Broglie, submitted.

Quantum mechanics (QM) and quantum electrodynamics (QED) are often touted as the most successful theories ever. In this paper, this claim is critically evaluated by a test of internal consistency for the ability to calculate the conjugate observables of the nature of the free electron, ionization energy, elastic electron scattering, and the excited states of the helium atom using the same solution for each of the separate experimental measurements. It is found that in some cases quantum gives good numbers, but the solutions are meaningless numbers since each has no relationship to providing an accurate physical model. Rather, the goal is to mathematically reproduce an experimental or prior theoretical number using adjustable parameters including arbitrary wave functions in computer algorithms with precision that is often much greater (e.g. 8 significant figures greater) than possible based on the propagation of errors in the measured fundamental constants implicit in the physical problem. Given the constraints of adherence to physical laws and internal consistency, an extensive literature search indicates that quantum mechanics has never solved a single physical problem correctly including the hydrogen atom and the next member of the periodic chart, the helium atom. Rather than using postulated unverifiable theories that treat atomic particles as if they were not real, physical laws are now applied to the same problem. In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, a classical approach is explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level. The proverbial view deeply seated in the wave-particle duality notion that there is no large-scale physical counterpart to the nature of the electron is shown not to be correct. Physical laws and intuition may be restored when dealing with the wave equation and quantum atomic problems. Specifically, a theory of classical quantum mechanics (CQM) was derived from first principles as reported previously [1-6] that successfully applies physical laws to the solution of atomic problems that has its basis in a breakthrough in the understanding of the stability of the bound electron to radiation. Rather than using the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy.* Although it is well known that an

accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. A simple invariant physical model arises naturally wherein the predicted results are extremely straightforward and internally consistent requiring minimal math as in the case of the most famous equations of Newton, Maxwell, Einstein, de Broglie, and Planck on which the model is based. No new physics is needed; only the known physical laws based on direct observation are used. The accurate solution of the helium atom is confirmed by the agreement of predicted and observed conjugate parameters using the same unique physical model in all cases.

For examples of the successes of the relativistic theory of CQM, see Section 55 above and the paper:

107. **R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics essays, submitted.**

The claim that quantum electrodynamics (QED) is the most successful theory in history is critically evaluated. The Dirac equation was postulated in 1926 as a means to remedy the nonrelativistic nature of the Schrödinger equation to provide the missed fourth quantum number. The positive as well as negative square root terms provided an argument for the existence of negative energy states of the vacuum, virtual particles, and corresponding so-called quantum electrodynamics (QED) computer algorithms for calculating unexpected observables such as the Lamb shift and the anomalous magnetic moment of the electron. It is true that is possible to calculate to a high degree of precision the very small correction to the classical magnetic moment of a point-particle electron using QED, but it is at the expense of any reasonable or verifiable physics. The method relies on a string of far-fetched and unverifiable or disproved assumptions such as (1) infinite electric and magnetic fields that are arbitrarily normalized, (2) a "zoo" of infinite numbers of virtual particles at every point in space, (3) polarization of the vacuum by the proposed virtual particles, (4) postulated participation of the members of the zoo in myriad schemes to cause the so-called polarization, (5) the contribution from each such scheme corresponds to a coefficient based on the product of ratio of the mass of the virtual particle to that of the real particle being experimentally observed and α / π, and (6) the schemes can be arbitrarily truncated to avoid further infinities. Due to the lack of rigor and a physical basis, QED calculations are argued to be

meaningless. In a broader sense, the connection between the underlying quantum mechanics and reality is more than just a "philosophical" issue. It reveals that quantum mechanics is not a correct or complete theory of the physical world and that inescapable internal inconsistencies and incongruities arise when attempts are made to treat it as a physical as opposed to a purely mathematical "tool". Some of these issues are discussed in a review by Laloë [1]. Moreover, Dirac's original attempt to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gives rise to electron spin is achievable using a classical approach. Starting with the same essential physics as Bohr, Schrödinger, and Dirac of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, advancements in the understanding of the stability of the bound electron to radiation is applied to solve for the exact nature of the electron. Rather than using the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy*. Although it is well known that an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. A simple invariant physical model arises naturally wherein the predicted results are extremely straightforward and internally consistent requiring minimal math as in the case of the most famous equations of Newton, Maxwell, Einstein, de Broglie, and Planck on which the model is based. No new physics is needed; only the known physical laws based on direct observation are used. Rather than invoking untestable "flights of fantasy", the results of QED such as the anomalous magnetic moment of the electron, the Lamb Shift, the fine structure and hyperfine structure of the hydrogen atom, and the hyperfine structure intervals of positronium and muonium can be solved exactly from Maxwell's equations to the limit possible based on experimental measurements which confirms QED's illegitimacy as representative of reality.

Further examples of CQM results from closed-form equations containing fundamental constants only that can not be reproduced by SQM are given in attached

Tables summarizing the results of the calculated and experimental parameters of H_2, D_2, H_2^+ and D_2^+, one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen,

sixteen, seventeen, eighteen, nineteen, and twenty-electron atoms, the excited states of helium, the electron g factor, and relations between fundamental particles. The closed-form derivations from Maxwell's equations given in

The Grand Unified Theory of Classical Quantum Mechanics posted at http://www.blacklightpower.com/bookdownload.shtml

contain fundamental constants only. The nature of the chemical bond is given in Chp. 12. The atoms are solved exactly in Chps. 1, 7, and 10. The excited states of helium are solved exactly in Chp. 9. The electron g factor and relations between fundamental particles are given in Chp. 1 and Chps. 27 and 30, respectively.

Section 70

Examiner Souw's analysis is further flawed, as demonstrated by the following statements appearing on Appendix page 20:

> Similarly, Applicant's arguments regarding the instability of excited states based on Quantum Electrodynamics (QED) and Dirac's theory must be disqualified, since Applicant has evidently misunderstood the most basic element of the Dirac theory, specifically regarding the physical concept and the mathematics of Dirac's 4-vector, as described in more details in section 6, subparagraph (c). Therefore, Applicant's argument on this subject matter remains unpersuasive.

The Examiner's statement "regarding the physical concept" is odd. If the Examiner insists that physics must apply to the hydrogen atom, then Dirac's equation is not a valid description as discussed in the following papers:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One-Through Twenty-Electron Atoms", Physics Essays, submitted.

94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

Specifically, the incorrectness of Dirac's equation is revealed in Applicant's paper:

107. **R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics essays, submitted.**

The claim that quantum electrodynamics (QED) is the most successful theory in history is critically evaluated. The Dirac equation was postulated in 1926 as a means to remedy the nonrelativistic nature of the Schrödinger equation to provide the missed fourth quantum number. The positive as well as negative square root terms provided an argument for the existence of negative energy states of the vacuum, virtual particles, and corresponding so-called quantum electrodynamics (QED) computer algorithms for calculating unexpected observables such as the Lamb shift and the anomalous magnetic moment of the electron. It is true that is possible to calculate to a high degree of precision the very small correction to the classical magnetic moment of a point-particle electron using QED, but it is at the expense of any reasonable or verifiable physics. The method relies on a string of far-fetched and unverifiable or disproved assumptions such as (1) infinite electric and magnetic fields that are arbitrarily normalized, (2) a "zoo" of infinite numbers of virtual particles at every point in space, (3) polarization of the vacuum by the proposed virtual particles, (4) postulated participation of the members of the zoo in myriad schemes to cause the so-called polarization, (5) the

contribution from each such scheme corresponds to a coefficient based on the product of ratio of the mass of the virtual particle to that of the real particle being experimentally observed and α / π, and (6) the schemes can be arbitrarily truncated to avoid further infinities. Due to the lack of rigor and a physical basis, QED calculations are argued to be meaningless. In a broader sense, the connection between the underlying quantum mechanics and reality is more than just a "philosophical" issue. It reveals that quantum mechanics is not a correct or complete theory of the physical world and that inescapable internal inconsistencies and incongruities arise when attempts are made to treat it as a physical as opposed to a purely mathematical "tool". Some of these issues are discussed in a review by Laloë [1]. Moreover, Dirac's original attempt to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gives rise to electron spin is achievable using a classical approach. Starting with the same essential physics as Bohr, Schrödinger, and Dirac of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, advancements in the understanding of the stability of the bound electron to radiation is applied to solve for the exact nature of the electron. Rather than using the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy*. Although it is well known that an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. A simple invariant physical model arises naturally wherein the predicted results are extremely straightforward and internally consistent requiring minimal math as in the case of the most famous equations of Newton, Maxwell, Einstein, de Broglie, and Planck on which the model is based. No new physics is needed; only the known physical laws based on direct observation are used. Rather than invoking untestable "flights of fantasy", the results of QED such as the anomalous magnetic moment of the electron, the Lamb Shift, the fine structure and hyperfine structure of the hydrogen atom, and the hyperfine structure intervals of positronium and muonium can be solved exactly from Maxwell's equations to the limit possible based on experimental measurements which confirms QED's illegitimacy as representative of reality.

II. Quantum Electrodynamics (QED)

Quantum mechanics failed to predict the results of the Stern-Gerlach experiment which indicated the need for an additional quantum number. In quantum mechanics, the spin angular momentum of the electron is called the

"intrinsic angular momentum" since no physical interpretation exists. (Currents corresponding to the observed magnetic field of the electron can not exist in one dimension of four dimensional spacetime where Ampere's law and the intrinsic special relativity determine the corresponding unique current.) The Schrödinger equation is not Lorentzian invariant in violation of special relativity. The Schrödinger equation also misses the Lamb shift, the fine structure, and the hyperfine structure completely, and it is not stable to radiation. Quantum electrodynamics was proposed by Dirac in 1926 to provide a generalization of quantum mechanics for high energies in conformity with the theory of special relativity and to provide a consistent treatment of the interaction of matter with radiation. But, it does not bridge the gap between quantum mechanics and special relativity. From Weisskopf [19], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; (1) does not explain nonradiation of bound electrons; (2) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; (3) it admits solutions of negative rest mass and negative kinetic energy; (4) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; (5) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise. Dirac's postulated relativistic wave equation gives the inescapable result of a cosmological constant that is at least 120 orders of magnitude larger than the best observational limit due to the unacceptable states of negative mass for the description of the vacuum as discussed previously [2-7, 9-10][24]. The negative mass states further create an absolute "ether"-like frame in violation of special relativity which was disproved by the Michelson-Morley experiment.

In retrospect, Dirac's equation which was postulated to explain spin relies on the unfounded notions of negative energy states of the vacuum, virtual

[24] The Rutherford experiment demonstrated that even atoms are comprised of essentially empty space [20]. Zero-point field fluctuations, virtual particles, and states of negative energy and mass invoked to describe the vacuum are nonsensical and have no basis in reality since they have never been observed experimentally and would correspond to an essentially infinite cosmological constant throughout the entire universe including regions of no mass. As given by Waldrop [21], "What makes this problem into something more than metaphysics is that the cosmological constant is observationally zero to a very high degree of accuracy. And yet, ordinary quantum field theory predicts that it ought to be enormous, about 120 orders of magnitude larger than the best observational limit. Moreover, this prediction is almost inescapable because it is a straightforward application of the uncertainty principle, which in this case states that every quantum field contains a certain, irreducible amount of energy even in empty space. Electrons, photons, quarks—the quantum field of every particle contributes. And that energy is exactly equivalent to the kind of pressure described by the cosmological constant. The cosmological constant has accordingly been an embarrassment and a frustration to every physicist who has ever grappled with it."

particles, and gamma factors; thus, it can not be the correct description of a bound electron even though it gives an addition quantum number interpreted as corresponding to the phenomenon of electron spin. Ironically, it is not even internally consistent with respect to its intent of being in accord with special relativity. In addition to violating Maxwell's equation with respect to stability to radiation wherein Maxwell's equations are implicit and the internal inconsistency with special relativity regarding the classical electron radius and states of negative rest mass and negative kinetic energy as given by Weisskopf [19], the Dirac equation violates Einstein causality and locality and conservation of energy as shown by the Klein Paradox discussed previously [2, 4, 7][25]. Furthermore, everyday observation demonstrates that causality and locality always hold. Einstein also argued that a probabilistic versus deterministic nature of atomic particles leads to disagreement with special relativity. In fact, the nonlocality result of the Copenhagen interpretation violates causality as shown by Einstein, Podolsky, and Rosen (EPR) in a classic paper [22] that presented a paradox involving instantaneous (faster-than-light) communication between particles called "spooky action at a distance" which led them to conclude that quantum mechanics is not a complete or correct theory. The implications of the EPR paper and the exact Maxwellian predictions of "spooky action" and "entanglement" experiments, incorrectly interpreted in the context of quantum mechanic, are given in Chp. 37 of Ref. [7].

In 1947, contrary to Dirac's predictions, Lamb discovered a $1000\ MHz$ shift between the $^2S_{1/2}$ state and the $^2P_{1/2}$ state of the hydrogen atom [24]. This so called Lamb Shift marked the beginning of modern quantum electrodynamics. In the words of Dirac [25], "No progress was made for 20 years. Then a development came initiated by Lamb's discovery and explanation of the Lamb Shift, which fundamentally changed the character of theoretical physics. It involved setting up rules for discarding ...infinities..." Renormalization is presently believed to be required of any fundamental theory of physics [26]. However, dissatisfaction with renormalization has been expressed at various times by many physicists including Dirac [27] who felt that, "This is just not sensible mathematics. Sensible mathematics

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[25] Oskar Klein pointed out a glaring paradox implied by the Dirac equation which was never resolved [23]. "Electrons may penetrate an electrostatic barrier even when their kinetic energy, $E - mc^2$ is lower than the barrier. Since in Klein's example the barrier was infinitely broad this could not be associated with wave mechanical tunnel effect. It is truly a paradox: Electrons too slow to surpass the potential, may still only be partially reflected. ...Even for an infinitely high barrier, i.e. $r_2 = 1$ and energies $\approx 1\ MeV$, (the reflection coefficient) R is less than 75%! From (2) and (3) it appears that as soon as the barrier is sufficiently high: $V > 2mc^2$, electrons may transgress the repulsive wall—seemingly defying conservation of energy. ...Nor is it possible by way of the positive energy spectrum of the free electron to achieve complete Einstein causality."

involves neglecting a quantity when it turns out to be small—not neglecting it just because it is infinitely great and you do not want it!"

Albeit, the Dirac equation did not predict the Lamb shift or the electron g factor [24, 28-29], its feature of negative-mass states of the vacuum gave rise to the postulates of QED that has become a center piece of quantum mechanics to explain these and other similar observations. One of QED's seminal aspects of renormalization which was subsequently grafted into atomic theory was a turning point in physics similar to the decision to treat the electron as a point-particle-probability wave, a point with no volume with a vague probability wave requiring that the electron have an infinite number of positions and energies including negative and infinite energies simultaneously. The adoption of the probabilistic versus deterministic nature of atomic particles violates all physical laws including special relativity with violation of causality as pointed out by Einstein [22] and de Broglie [30]. Consequently, it was rejected even by Schrödinger [31].

Pure mathematics took the place of physics when calculating subtle shifts of the hydrogen atomic energy levels. Moreover, in QED, the pure mathematics approach has been confused with physics to the point that virtual particles are really considered as causing the observable. The justification for the linkage is often incorrectly associated with the usage of series expansion and variational methods to solve problems based on physical laws. But, series expansion of an equation based on a physical action or variation of a physical parameter of the equation versus the fabrication of an action based on fantastical untestable constructs that are represented by a series are clearly different. For example, the motion of a pendulum can be solved exactly in terms of an elliptic integral using Newtonian mechanics. Expansion of the elliptic integral in a power series and ignoring negligible terms in the series versus setting up of arbitrary rules for *discarding infinities* are clearly not the same. Furthermore, inventing virtual particles that have an action on space, and subsequently on an electron, versus expanding terms in the energy equation due to a gravitating body causing a gravitational field and thus an action on the pendulum are very different. In QED, virtual particles are not merely a sustitutional or expansion variable. They are really considered as causing the observable.

In a further exercise of poor science, virtual-particle-based calculations are even included in the determination of the fundamental constants which are circularly used to calculate the parameter ascribed to the virtual particles. For example, using the electron magnetic moment anomaly in the selection of the best value of the fine structure constant, the CODATA publication [32] reports the use of virtual particles:

> "The term A1 is mass independent and the other terms are functions of the indicted mass ratios. For these terms the lepton in the

numerator of the mass ratio is the particle under consideration, while the lepton in the denominator of the ratio is the virtual particle that is the source of vacuum polarization that gives rise to the term."

There is no direct evidence that virtual particles exist or that they polarize the vacuum. Even their postulation is an oxymoron.

Throughout the history of quantum theory, wherever there was an advance to a new application, it was necessary to repeat a trial-and -error experimentation to find which method of calculation gave the right answers. Often the textbooks present only the successful procedure as if it followed from first principles and do not mention the actual method by which it was found. In electromagnetic theory based on Maxwell's equations, one deduces the computational algorithm from the general principles. In quantum theory, the logic is just the opposite. One chooses the principle (e.g. phenomenological Hamiltonians) to fit the empirically successful algorithm. For example, we know that it required a great deal of art and tact over decades of effort to get correct predictions out of QED. The QED method of the determination of $(g-2)/2$ from the *postulated* Dirac equation is based on a *postulated* power series of α/π where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term which is processed over decades using ad hoc rules to remove infinities from each term that arises from *postulated* scores of *postulated* Feynman diagrams. The solution so obtained using the perturbation series further requires a *postulated* truncation since the series *diverges*. Mohr and Taylor reference some of the Herculean efforts to arrive at g using QED [32]:

"the sixth-order coefficient $A_1^{(6)}$ arises from 72 diagrams and is also known analytically after nearly 30 years of effort by many researchers [see Roskies, Remiddi, and Levine (1990) for a review of the early work]. It was not until 1996 that the last remaining distinct diagrams were calculated analytically, thereby completing the theoretical expression for $A_1^{(6)}$".

For the right experimental numbers to emerge, one must do the calculation (i.e. subtract off the infinities) in one particular way and not in some other way that appears in principle equally valid. For example, Milonni [33] presents a QED derivation of the magnetic moment of the electron which gives a result of the wrong sign and requires the introduction of an

"upper limit K in the integration over $k=\omega/c$ in order to avoid a divergence."

A differential mass is arbitrarily added, then

"the choice $K=0.42mc/\hbar$ yields $(g-2)/2=\alpha/2\pi$ which is the relativistic QED result to first order in α. [...] However, the reader is warned not to take these calculations too seriously, for the result $(g-2)/2=\alpha/2\pi$ could

be obtained by retaining only the first (radiation reaction) term in (3.112) and choosing $K = 3mc/8\hbar$. It should also be noted that the solution $K \cong 0.42mc/\hbar$ of (3.112) with $(g-2)/2 = \alpha/2\pi$ is not unique."

Such an ad hoc nonphysical approach makes incredulous:

" the cliché that QED is the best theory we have!" [34]

or the statement that:

"The history of quantum electrodynamics (QED) has been one of unblemished triumph" [35].

There is a corollary, noted by Kallen: from an inconsistent theory, any result may be derived.

In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, a classical approach was explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level [2-7]. Physical laws and intuition are restored when dealing with the wave equation and quantum mechanical problems. Specifically, a theory of classical quantum mechanics (CQM) was derived from first principles that successfully applies physical laws on all scales. Rather than use the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy.* The electron must be extended rather than a point. On this basis with the assumption that physical laws including Maxwell's equation apply to bound electrons, the hydrogen atom was solved exactly from first principles. The remarkable agreement across the spectrum of experimental results indicates that this is the correct model of the hydrogen atom.

It was shown previously that quantum mechanics does not explain the stability of the atom to radiation [2]; whereas, the Maxwellian approach gives a natural relationship between Maxwell's equations, special relativity, and general relativity. CQM holds over a scale of spacetime of 85 orders of magnitude—it correctly predicts the nature of the universe from the scale of the quarks to that of the cosmos [3]. A review is given by Landvogt [36]. In a third paper, the atomic physical approach was applied to multielectron atoms that were solved exactly disproving the deep-seated view that such exact solutions can not exist according to quantum mechanics. The general solutions for one through twenty-electron atoms are given in Ref [4]. The predictions are in remarkable agreement with the experimental values known for 400 atoms and ions. A fourth paper presents a solution based on physical laws and fully compliant with Maxwell's equations that solves the 26

parameters of molecular ions and molecules of hydrogen isotopes in closed-form equations with fundamental constants only that match the experimental values [5]. In a fifth paper, the nature of atomic physics being correctly represented by quantum mechanics versus classical quantum mechanics is subjected to a test of internal consistency for the ability to calculate the conjugate observables using the same solution for each of the separate experimental measurements [6]. It is confirmed that the CQM solution is the accurate model of the helium atom by the agreement of predicted and observed conjugate parameters of the free electron, ionization energy of helium and all two electron atoms, ionization energies of multielectron atoms, electron scattering of helium for all angles, and all He I excited states using the same unique physical model in all cases. Over five hundred conjugate parameters are calculated using a unique solution of the two-electron atom without any adjustable parameters to achieve overall agreement to the level obtainable considering the error in the measurements and the fundamental constants in the closed-form equations.

In contrast, the quantum fails utterly. Ad hoc computer algorithms are used to generate meaningless numbers with internally inconsistent and nonphysical models that have no relationship to physics. Attempts are often made to numerically reproduce prior theoretical numbers using adjustable parameters including arbitrary wave functions in computer programs with precision that is often much greater (e.g. 8 significant figures greater) than possible based on the propagation of errors in the measured fundamental constants implicit in the physical problem.

In this sixth paper of a series, rather than invoking renormalization, untestable virtual particles, and polarization of the vacuum by the virtual particles, the results of QED such as the anomalous magnetic moment of the electron, the Lamb Shift, the fine structure and hyperfine structure of the hydrogen atom, and the hyperfine structure intervals of positronium and muonium (thought to be only solvable using QED) are solved exactly from Maxwell's equations to the limit possible based on experimental measurements.

Section 71

Other aspects of Examiner Souw's analysis also prove to be nonsensical, such as the following discussion on Appendix page 20:

4. Regarding "Applicant misunderstands the most basic fundamentals of the QM theory"

(a) Applicant's attempt to argue that Applicant's electron wave function p(r,t) involving ä-function does not need to satisfy --or must not be a solution of-- the wave equation (pg.45) is totally unacceptable, and hence, unpersuasive because applicant's response contradicts the mathematical requirement that any valid solution must satisfy the generic equation.

The Examiner's comment about Applicant's argument being "unpersuasive because applicant's response contradicts the mathematical requirement that any valid solution must satisfy the generic equation" is not well taken. On which physical law is this statement by the Examiner based? In fact, radial motion in an inverse-squared field according to SQM violates stability and conservation of energy, as pointed out in Section 63 above.

Section 72

On Appendix page 20, Examiner Souw further argues, inconsistently, that:

> Applicant's insistence that his ä-function-based "solution" p(r,t) does not need to satisfy --or must not be a solution of-- the wave equation, violates the basic laws of physics and mathematics. It must be emphasized that the entire physics and mathematics that have been developed since Newton and Leibniz form together a non-self-contradictory entity generally accepted by the scientific community. It is a high barrier to disprove what is accepted by conventional science, such as QM (Quantum Mechanics).

Regarding the false assertion that Applicant's position "violates the basic laws of physics and mathematics," the Examiner offers no law of nature that requires this to be true. In fact, it is not even internally consistent with SQM' s rigid-rotor equation [McQuarrie, D. A., *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), pp. 206-225]. See Section 63 above.

Section 73

Examiner Souw is also flat out wrong in his statement on page 21 of the Appendix that:

> Since Applicant's GUT is entirely based on this ä-function-based electron wave function p(r,t) which is not a solution of his own starting wave equation, Applicant's flawed GUT does not provide any theoretical support to this patent application. Any further attempt to argue the patentability of his application by relying on GUT will be dismissed as UNPERSUASIVE with referral to this section, ***II.4.a.***.

This is not true at all. As shown in Section 63 above and GUT Chp. 1 [Ref. #1], the condition of nonradiation requires that the three-dimensional wave equation plus time be reduced to the two-dimensional wave equation plus time. This equation IS rigorously solved for 100's of observables with remarkable agreement between predicted and experimental values. The results are absolutely predictive in that the same solution for the electron is used in all of the 100's of predictions. There is not a single example in SQM where this is the case. Others agree with Applicant as indicated in Section 54 above. The Examiner's refusal to acknowledge these facts is telling.

Section 74

Examiner Souw continues his flawed analysis by stating on Appendix page 21:

> (b) Applicant's angular momentum wave functions (instead of eigenfunctions), as derived in GUT and partly reproduced on pg.58-64, are mathematically flawed and in direct violation of the conventional QM, as already described in the previous Appendix. It turns out, Applicant's rejection of QM is solely caused by Applicant's misunderstanding and misinterpretation of the QM, the latter having been acknowledged in the art as being the most successful theory in the whole history of physics. The validity of QM has been quantitatively verified by multiple generations of physicists/scientists and by thousands, if not millions of phenomena and effects encountered in science and technology.

The angular functions are charge-density waves that describe real charge moving in space and time. They do not refer to the weird probability-density functions of quantum mechanics that are nonphysical. The CMQ results match the data exactly.

In contrast, the SQM result has many problems in this regard regarding infinities and nondegeneracy in the absence of a magnetic field as reported in the literature previously:

80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

The hype associated with standard quantum mechanics is incredible, especially given that it has never solved a single problem using physical laws with internal consistency and comprises nonphysical computer curve-fitting algorithms. It is not predictive since there is not a single example where a SQM result can be used to predict another, even known result. Some of the hype is discussed in Section 70 above.

The made-up procedures and ad hoc curve fitting approaches discussed in Section 70, Appendix II of Mills GUT (Ref. #1), and paper #107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted, make these types of statements incredulous. SQM can not match the closed-form results given in the QED paper (#107) and Mills GUT, some of which are summarized in Sections 55 and 69 above.

Section 75

Examiner Souw repeats prior erroneous statements on page 21 of the Appendix, wherein he claims:

> In contrast, applicant's flawed "theory" has not been verified even by a single experiment conducted by an independent third party to date. Thus, Applicant's argument regarding alleged flaws in QM is unpersuasive.

CQM unifies Maxwell's equations, special, and general relativity with atomic physics. It predicts gravitation from fundamental particles and predicts their masses. It gives closed-form equations with fundamental constants only for the masses and the evolution of the cosmos as a function of time. Applicant's theory correctly predicted by mass of the top quark before it was detected on the D0 detector. It also correctly predicted the acceleration of the expansion of the universe before it was detected to the shock of cosmology experts.

CQM also predicted the existence of hydrinos before experiments were run. In addition to the results given in Applicant's 112 experiments, independent researchers have also conformed this prediction of CQM, as summarized in the 51 reports and papers given in the section entitled "Independent Test Results". Since SQM is not predictive, it is not surprising that it did not and can not predict any of these discoveries. For example, the ratios of the masses of fundamental particles that can not be reproduced by SQM are:

RELATIONS BETWEEN FUNDAMENTAL PARTICLES

The relations between the lepton masses and neutron to electron mass ratio which are independent of the definition of the imaginary time ruler ti including the contribution of the fields due to charge production are given in terms of the dimensionless fine structure constant α only:

$$\frac{m_\mu}{m_e} = \left(\frac{\alpha^{-2}}{2\pi}\right)^{\frac{2}{3}} \frac{\left(1+2\pi\frac{\alpha^2}{2}\right)}{\left(1+\frac{\alpha}{2}\right)} = 206.76828 \qquad (206.76827)^{a}$$

$$\frac{m_\tau}{m_\mu} = \left(\frac{\alpha^{-1}}{2}\right)^{\frac{2}{3}} \frac{\left(1 + \frac{\alpha}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 16.817 \qquad (16.817)$$

$$\frac{m_\tau}{m_e} = \left(\frac{\alpha^{-3}}{4\pi}\right)^{\frac{2}{3}} \frac{\left(1 + 2\pi\frac{\alpha^2}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 3477.2 \qquad (3477.3)$$

$$\frac{m_N}{m_e} = \frac{12\pi^2}{1-\alpha}\sqrt{\frac{\sqrt{3}}{\alpha}} \frac{\left(1 + 2\pi\frac{\alpha^2}{2}\right)}{\left(1 - 2\pi\frac{\alpha^2}{2}\right)} = 1838.67 \qquad (1838.68)$$

[a] Experimental according to the 1998 CODATA and the Particle Data Group [K. Hagiwara et al., Phys. Rev. D 66, 010001 (2002); http://pdg.lbl.gov/2002/s035.pdf; P. J. Mohr and B. N. Taylor, "CODATA recommended values of the fundamental physical constants: 1998", Reviews of Modern Physics, Vol. 72, No. 2, April, (2000), pp. 351-495].

The agreement between the experimental and observed values is truly remarkable, as is the Examiner's failure to recognize this astonishing accomplishment.

Section 76

Examiner Souw further argues on page 21 of the Appendix that:

(c) Applicant's remark, *"there is no a priori basis for any theory to be correct"*, does not contradict the Examiner's view. However, there are plenty of a priori basis for a theory to be incorrect, e.g., if the theory is incredible, illogical and/or self-contradictory, such as Applicant's GUT and hydrino theory.

Since SQM predicts infinities in the electron's electric and magnetic fields and they are not observed, it is proven wrong. Since SQM predicts that the electron in the n=1 state has instantaneous acceleration, it must radiate. Since radiation is not observed, again, it is proven wrong. Since the angular solutions that are square-integrable predict large nondegeneracy in the orbital angular momenta and energies

and these are not observed, it is further proven wrong. Since SQM predicts the electron can move radially from the nucleus (and even be inside the nucleus) violating conservation of energy and angular momentum and such violation is not observed, SQM is proven wrong yet again. The list goes on and on.

See:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

In contrast Applicant's CQM is based on Maxwell's equation and special and general relativity. These physical laws have never been proven wrong, and now Applicant has shown how to solve them on the level of the atom with stunningly accurate results.

Section 77

Examiner Souw argues on pages 21-22 of his Appendix that:

The Examiner's view on Applicant's theory and experimental evidence is totally different than Applicant's: (a) A correct scientific theory must be mathematically and conceptually self-consistent, and should not contain self-contradiction, e.g., mathematical flaws. In this regard, Applicant's entire theory, as documented in the GUT document, contains an unprecedented amount of mathematical flaws and errors, as already demonstrated in the previous Appendixes included in all the office actions of record, some of which are now repeated, confirmed and emphasized.

The Examiner has it backwards. These deficiencies rest with SQM, not CQM, as discussed in the prior theory sections of this Response.

Section 78

The Examiner asserts on page 22 of his Appendix that:

(b) A correct scientific concept must be proven by experimental evidence. In this regard, NONE of Applicant's "experimental evidence" is scientifically valid, as already discussed by the Primary Examiner(s) in his/her main Office Action. Applicant's alleged "evidence" falls into three categories, which have been discussed in Part I and already presented in the previous Appendix.

This redundant issue has already been dismissed in the Experimental sections of this Response.

Section 79

Examiner Souw also wrongly argues on Appendix page 22 that:

5. Regarding Applicant's misunderstanding of Haus's non-radiative condition

(a) On pg. 51/lines 4-5, Applicant recites: *"a time dependent charge corresponds to a current"*. This is just one of the unprecedented number of mathematical flaws and misunderstanding of elementary physical

concepts in Applicant's GUT. The mathematical flaw lies in the fact that a current ***J*** is a vector quantity (or field), whereas p(***r***,t) is a scalar, so they can never be the same as claimed by Applicant (J??/ñ?t, since the left hand side is a vector and the right hand side is a scalar). The physical flaw lies in the fact that they are fundamentally of different natures. Only together (hence their different natures!) they form the charge conservation law, i.e., by virtue of the well known formula ***div·J***+?ñ/?t =0 (note the scalar operation ***div·*** on vector ***J***; not ***J*** itself). The GUT is completely silence on such mathematical relation and/or operation. Hence, any hindsight argument in this direction from Applicant's side inevitably would be automatically considered invalid and unpersuasive.

Regarding the Examiner's argument based on "the fact that a current ***J*** is a vector quantity (or field), whereas p(***r***,t) is a scalar," Applicant points out that he correctly considered the vector aspect of the current. In the paper 58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press, appears:

The current due to the time dependent term is

$$\begin{aligned}
\mathbf{J} &= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2} N[\delta(r-r_n)]\operatorname{Re}\{Y_\ell^m(\theta,\phi)\}[\mathbf{u}(t)\times\mathbf{r}] \\
&= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2} N[\delta(r-r_n)]\operatorname{Re}\{Y_\ell^m(\theta,\phi)e^{i\omega_n t}\}[\mathbf{u}\times\mathbf{r}] \\
&= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2} N'[\delta(r-r_n)]\operatorname{Re}\left(P_\ell^m(\cos\theta)e^{im\phi}e^{i\omega_n' t}\right)[\mathbf{u}\times\mathbf{r}] \\
&= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2} N'[\delta(r-r_n)]\left(P_\ell^m(\cos\theta)\cos\left(m\phi+\omega_n' t\right)\right)[\mathbf{u}\times\mathbf{r}] \\
&= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2} N'[\delta(r-r_n)]\left(P_\ell^m(\cos\theta)\cos\left(m\phi+\omega_n' t\right)\right)\sin\theta\hat{\phi}
\end{aligned} \tag{21}$$

where to keep the form of the spherical harmonic as a traveling wave about the z-axis, $\omega_n' = m\omega_n$ and N and N' are normalization constants. The vectors are defined as

$$\hat{\phi} = \frac{\hat{u}\times\hat{r}}{|\hat{u}\times\hat{r}|} = \frac{\hat{u}\times\hat{r}}{\sin\theta}; \qquad \hat{u} = \hat{z} = orbital\ axis \tag{22}$$

$$\hat{\theta} = \hat{\phi}\times\hat{r} \tag{23}$$

"^" denotes the unit vectors $\hat{u} \equiv \frac{\mathbf{u}}{|\mathbf{u}|}$, non-unit vectors are designed in bold, and the current function is normalized.

<u>Section 80</u>

Examiner Souw further argues on page 23 of his Appendix that:

> (b) In GUT, as well as on pg. 51/ff of 83, Applicant's Eqs. 1-39 through 1.45 are mathematically flawed, as already recited in the previous Appendix, sect.4/pg.3/lines 8-12 and pg.4/lines 9. One of ordinary skill in the art can easily show that Applicant's charge density p(***r***,t) is <u>neither</u> a solution of the Maxwell/Helmholtz equation in terms of Laplace operator <u>nor</u> the Schrödinger equation, i.e., by virtue of the fully analytical integral representation of the ä-function that can be mathematically treated in a rigorous manner (see original Appendix, section 4). Not only is this <u>another</u> example out of an unprecedented number of mathematical flaws and misunderstanding of elementary physical concepts in Applicant's GUT, but most importantly, a solid proof that Applicant's derivation of the hydrino theory is based on the failure to apply rigorous mathematics as proofs as every physics theory should be based upon

Applicant's charge density functions are solutions of the two-dimensional wave equation plus time, as discussed above in Sections 63 and 73 above. These solutions are well known as given in Chp I of Mills GUT and McQuarrie, D. A., *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), pp. 206-225. They satisfy the constraint of nonradiation according to Maxwell's equation as shown in the following peer-reviewed paper:

58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.

and in Chp 1 and Appendix I of Mills GUT. They are unprecedented in their success at predicting experimental observables as discussed in previous sections, including Sections 54-55 and 69-70.

<u>Section 81</u>

Examiner Souw further argues on page 23 of the Appendix that:

(c) Applicant's Eq. 1.41 to 1.45 are based on an incorrect application -- and is a result of his serious misunderstanding-- of the Special Relativity Theory, specifically regarding the inapplicability of the theory to a circulating electron, as already described in previous Appendix. Applicant has failed to address the Examiner's refutation and show a proper understanding of the Relativity Theory in his response to the Examiner's Appendix (see also last section 10).

Applicant's theory is the most successful to date at applying special relativity to the atom, as shown in Section 55 of this Response. SQM can not match these results and is incompatible with special relativity as shown in:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.

SQM lacks Einstein causality and even resurrects the disproved ether. Since the electron motion can not be defined, it is impossible to apply special relativity to SQM, which indicates a huge failure. However, another problem arises by correcting the mass while maintaining the invariance of charge under special relativity. The mass to charge ratio is then not invariant; thus, the Bohr magneton of magnetic moment is not invariant. Since experimentally it is invariant, SQM is disproved in yet another instance.

Furthermore, in additional refutation of past rejections by the Examiner:
The electron moves in an orbit relative to the laboratory frame. Muons and electrons are both leptons. Time dilation of muonic decay due to relativistic motion in a cyclotron orbit relative to a stationary laboratory frame provides strong confirmation of special relativity and confirms that the electron's frame is an inertial frame. eB/m bunching of electrons in a gyrotron [P. Sprangle and A. T. Drobot, "The linear and self-consistent nonlinear theory of the electron cyclotron maser instability", IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-25, No. 6, June, (1977), pp. 528-544] occurs because the cyclotron frequency is inversely proportional to the relativistic

electron mass. This further demonstrates that the electron frame is an inertial frame and that electron mass and time dilation occur. The special relativistic relationship in polar coordinates is derived. The result of the treatment of the electron motion relative to the laboratory frame is in excellent agreement with numerous experimental observables such as the electron g factor, the invariance of the electron magnetic moment of μ_B and angular momentum of $\hbar$, the fine structure of the hydrogen atom, and the relativistically corrected ionization energies of one and two electron atoms given in:

102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted
107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.

and in the Excited States of the One-Electron Atom (Quantization) and The Two-Electron Atom sections of Mills GUT.

Section 82

On pages 23-24 of the Souw Appendix, the Examiner further argues:

(d) Applicant's statement on pg.55 that, "[t]he distinction between an eigenfunction and a wavefunction comprised of eigenfunctions is due entirely to a mathematical postulate of QM", is mathematically incorrect: Per definition, eigenfunctions are solutions of an eigenvalue equation. Not only the Schrödinger Equation (SE), but also the electromagnetic wave equation of Helmholtz are eigenvalue equations. Consequently, the monochromatic wave function exp i(kx-ùt) is an eigenfunction solution of the wave equation, and a wave packet can be constructed as a superposition of such eigenfunctions. Applicant's GUT theory is based on applicant's serious misunderstanding in this crucial subject matter.

What is there to be confused about? Applicant understands that the basic function sinwt is an eigenfunction; others may be more complicated, but the distinguishing feature is that the derivative is a constant times the function.

Applicant made the point in a prior Action that a sum of eigenfunctions is an eigenfunction. It is irrelevant that SQM requires that the eigenfunctions be square integrable, which is the original argument that the Examiner is diverting from. He admits that linear combinations of eigenfunctions do not work in SQM since SQM is not a theory based on physics. It is nonsensical to square a probability-wave function to get a charge or mass function. In CQM the electron states comprise the sum of a constant charge-density function corresponding to spin angular momentum and a spherically- and time-harmonic function that modulates the constant function and corresponds to orbital angular momentum. This eliminates the failures of SQM in providing a current corresponding to spin, the lack of degenerate orbital angular levels in the absence of a magnetic field, and other failings as reported previously in the literature:

17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

Section 83

Examiner Souw continues his flawed analysis by arguing on page 24 of his Appendix that:

6. Applicant's confusion regarding wavefunction and eigenfunction

(a) Due to applicant's misunderstanding of eigenfunctions (see above), applicant then proceeds to separate the physics of angular momentum from its mathematics (e.g., on pg.54-55, and once again on pg.64). A most important characteristic of modern science (ever since Newton) is, that physics must be quantitatively expressed in rigorous mathematics (besides it must be also experimentally verifiable, independent of time, location and observer). The mathematical basis for the QM concept, including the complementary property of position and momentum as well as the Heisenberg uncertainty principle (HUP), is the Fourier Transform, in which both the HLJP as well as the concept of eigenfunctions, as distinguished from a superposition (wavepacket), can be intuitively grasped by one of ordinary skill in the art.

Actually it is SQM that is not correct according to physical laws, and CQM does not suffer from these flaws as discussed in Sections 73, 80, and 82 above. The Examiner is correct that Applicant does not solve for a probability-density function that is square-integrable as in the case of SQM. Applicant has shown that this is not correct in that it leads to disagreement between predictions and experiments that do not occur in the case of CQM. The fact that SQM relies on such a probability-wave construct requires that it is implicitly in violation of physical laws as shown in:

80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

It is further trivially appreciated that mass and charge add linearly, not as the square of the sum.

Applicant admits that he has no idea what the Examiner is saying with the following string of seeming flights of fantasy:

> The mathematical basis for the QM concept, including the complementary property of position and momentum as well as the Heisenberg uncertainty principle (HUP), is the Fourier Transform, in which both the HUP as well as the concept of eigenfunctions, as distinguished from a superposition (wavepacket), can be intuitively grasped by one of ordinary skill in the art.

This speak is not found in any classical physics book that Applicant is aware of. Where in the literature is the Fourier Transform taken on the HUP for example, and what is its physical significance? In any event, Applicant's theory is intuitive and derived from physical laws so no such esoteric utterances arise.

Section 84

Examiner Souw further argues on pages 24-25 of his Appendix that:

> (b) On pg.55/lines 8-10 from bottom, Applicant's statement regarding the impossibility of zero rotational energy in case of zero angular momentum (L=0) has no basis whatsoever, and hence, is here dismissed and disregarded. For L=0, the wavefunction is known to be spherical symmetric, meaning that the electron is everywhere within 0? (è,ö)?2∂ with equal probability. To "see" an electron density probability that is inhomogeneous over the angle coordinates (è,ö), a superposition of angular momenta eigenfunctions is necessary, as described in the original Appendix, which also means that äL>0 and the system is no longer spherical-symmetric. A spherical-symmetric system (L=0) has a zero angular momentum, since $\boldsymbol{L^2 Y_{L.m1}}$(è,ö) =0 for **L**=0, and $\boldsymbol{L}Y_{o,o}$(è,ö)= ***(r*** x ***p)***$Y_{o,o}$(è,ö) with ***p*** being a differential operator (defined by McQuarrie [1] Eqs.6-81 & 6-83), is also identical to zero, since $Y_{o,o}$(è,ö) is a constant (see previous Appendix pg.5-6). Consequently, the rotational energy, E_R=L(L+1)_^{2}/2I (McQuarrie [1] Eq.6-61/pg.219), is also zero for L=0, whereas E_R= _^{2}/I for L=1, in direct contradiction to Applicant's claim that the lowest rotational energy is E_R=_^{2}/2mr^2, as recited on pg.55 lines 24-

25. Applicant has obviously misunderstood his own cited reference McQuarrie [1], i.e., by inserting L=1 (but not L=0) and $I=mr^2$ in Eq.6-61 on pg. 219 and 209, where r is there NOT the radius of hydrogen atom as Applicant would like to mean, but (r is) the inter-atomic distance in a diatomic molecule, whereas Applicant's m, or McQuarrie's ì., is its reduced mass, as recited in [1] on pg.212/Example 6-5. It is also clear that L=0 is inclusive in the complete set, as recited in Eq.6-60 in [1] on pg.209. McQuarrie [1] discusses in §6-5 to §6-7 the Rigid Rotator model, unambiguously reciting in the title of §6-5 that the Rigid Rotator is a Model for a Rotating Diatomic Molecule ([1}/pgs.210-221).

The Examiner admits that in SQM, the electron has no angular momentum, which is impossible for the case of any physical object bound by an inverse-squared force law, as shown in any basic mechanics book such as

G. R. Fowles, Analytical Mechanics, Third Edition, Holt, Rinehart, and Winston, New York, (1977), pp. 145-158.

Thus, the **Examiner has admitted that SQM does not agree with physical laws**.

Regarding Examiner Souw's comments regarding the "contradiction to Applicant's claim that the lowest rotational energy is $E_R=\_^2/2mr^2$, as recited on pg.55 lines 24-25," Applicant notes that, in CQM, the orbital angular momentum is zero for L=0, and the spin angular momentum is not zero as it must be and is given in Chp 1 of Mills GUT:

The z-axis projection of the spin angular momentum was derived in the Spin Angular Momentum of the Orbitsphere with $\ell = 0$ section.

$$L_z = I\omega \mathbf{i}_z = \pm\frac{\hbar}{2} \tag{1.78}$$

where ω is given by Eq. (1.55); so,

$\boldsymbol{\ell = 0}$

$$|L_z| = I\frac{\hbar}{m_e r^2} = \frac{\hbar}{2} \tag{1.79}$$

Thus,

$$I_z = I_{spin} = \frac{m_e r_n^2}{2} \tag{1.80}$$

From Eq. (1.51),

$$E_{rotational\ spin} = \frac{1}{2}\left[I_{spin}\omega^2\right] \tag{1.81}$$

From Eqs. (1.55) and (1.80),

$$E_{rotational} = E_{rotational\ spin} = \frac{1}{2}\left[I_{spin}\left(\frac{\hbar}{m_e r_n^2}\right)^2\right] = \frac{1}{2}\left[\frac{m_e r_n^2}{2}\left(\frac{\hbar}{m_e r_n^2}\right)^2\right] = \frac{1}{4}\left[\frac{\hbar^2}{2I_{spin}}\right] \tag{1.82}$$

When $\ell \neq 0$, the spherical harmonic is not a constant and the charge-density function is not uniform over the orbitsphere. Thus, the angular momentum can be thought of arising from a spin component and an orbital component.

The Examiner's mistakenly argues McQuarrie's rigid rotor problem, which does not apply for l=0.

Section 85

Examiner Souw continues his erroneous analysis by stating on page 25 of the Appendix that:

> Hydrogen atom is handled by McQuarrie [1] in §6-8 on pg.221 ff. As stated by McQuarrie [1] on pgs.222-223, Eqs. 6-99 & 6-100, the energy of a hydrogen electron for different quantum numbers (n,L,m) in the absence of magnetic field is <u>degenerate in (L,m)</u>, as recited on pg.225, line 20-22 of § 6-9, i.e., it depends only on the principal quantum n, with L satisfying 0=L=n-1 (Eq.6-101 in [1]/pg.223), i.e., <u>L=0 also inclusive</u>. Obviously, Applicant's has misunderstood the zero angular momentum case in his own cited reference, McQuarrie [1], for misinterpreting $Y_{O,O}$ as being a spin eigenfunction (GUT, Eqs.1.61-1.65) based on his erroneous understanding that L=0, or zero rotational energy, is impossible, as recited by Applicant on (pg.55, lines 24-25).

First of all, it is impossible to have zero rotational energy for a moving bound electron. Furthermore, despite what is says in McQuarrie [1], SQM has it wrong on the issue of degeneracy of hydrogen atomic energy levels, as reported in the literature previously:

80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

From Ref. #80:

1.) The HUP gives a lower limit to the product of **the *uncertainty* in the momentum and the *uncertainty* in the position—not the product of the momentum and the position**. The momentum or position could be arbitrarily larger or smaller than its uncertainty. For example, QM textbooks express the movement of the electron, and the HUP is an expression of the statistical aspects of this movement. McQuarrie [25], gives the electron speed in the $n = 1$ state of hydrogen as $2.18764\ X\,10^{6}\ m/\sec$. Remarkably, the uncertainty in the electron speed according to the HUP is $1.4\,X\,10^{7}\ m/\sec$ [26] which is an order of magnitude larger than the speed. The short comings of the theory are obvious given that the constant parameters of the hydrogen atom are known to 10 figure accuracy.

2.) Eq. (3) follows from the Schrodinger equation, not the Bohr theory. In the time independent Schrödinger equation, the kinetic energy of rotation K_{rot} is given by [20]

$$K_{rot} = \frac{\ell(\ell+1)\hbar^2}{2mr^2} \tag{11}$$

where

$$L = \sqrt{\ell(\ell+1)\hbar^2} \tag{12}$$

is the value of the electron angular momentum L for the state $Y_{lm}(\theta,\phi)$.

At page 365 Margenau and Murphy [20] state

> " but with the term $\frac{\ell(\ell+1)\hbar^2}{2mr^2}$ added to the normal potential energy. What is the meaning of that term? In classical mechanics, the energy of a particle moving in three dimensions differs from that of a one-dimensional particle by the kinetic energy of rotation, $\frac{1}{2}mr^2\omega^2$. This is precisely the quantity $\frac{\ell(\ell+1)\hbar^2}{2mr^2}$, for we have seen that $\ell(\ell+1)\hbar^2$ is the *certain* value of the square of the angular momentum for the state Y_ℓ, in classical language $(mr^2\omega^2)^2$ which is divided by $2mr^2$, gives exactly the kinetic energy of rotation."

For the n=1 state, $\ell = 0$; thus, **the angular momentum according to the Schrodinger equation is exactly zero—not $\hbar$.** Furthermore, the kinetic energy of rotation K_{rot} is also **zero**. As a consequence, it is internally inconsistent for Feynman to accept the HUP which arises from the Schrodinger equation on the one hand and that the electron obeys the classical Coulomb law and is bound in an inverse squared Coulomb field on the other. Rather than a kinetic energy of $\frac{\hbar^2}{2mr^2}$ which is added to the Coulomb energy of $-\frac{e^2}{r}$ to get the total energy, exactly zero should be added to the Coulomb energy. This is an inescapable nonsensical result which arises from the SE directly, and it can not be saved by incorrectly assigning the angular momentum as $\hbar$ from the uncertainty relationship. Furthermore, the result that L = K_{rot} **= exactly zero violates the HUP making the argument further internally inconsistent.** In addition, applying Eq. (3) to spherical harmonic solutions for Ψ with an exact momentum and energy for a given ℓ in Eqs. (11) and (12), respectively, requires that $\Delta\theta \to \infty$ since $\Delta L = 0$ in the relationship $\Delta L \Delta\theta \geq \frac{\hbar}{2}$. The result $\Delta\theta \to \infty$ is nonsensical. Postulating a linear combination of spherical harmonics is not consistent with a single momentum state and will not save the HUP since the linear combination is not an eigenfunction. Rather it is a wavefunction of a set that is not orthonormal (i.e. it violates QM postulates by not yielding the Kroenecker delta).

20. H. Margenau, G. M. Murphy, *The Mathematics of Chemistry and Physics*, D. Van Nostrand Company, Inc., New York, (1956), Second Edition, pp. 363-367.

From 17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.

In the time independent Schrodinger equation, the kinetic energy of rotation K_{rot} is given by

$$K_{rot} = \frac{\ell(\ell+1)\hbar^2}{2mr^2} \tag{10}$$

where

$$L = \sqrt{\ell(\ell+1)\hbar^2} \tag{11}$$

is the value of the electron angular momentum L for the state $Y_{lm}(\theta,\phi)$.

• In the time independent Schrodinger equation, the kinetic energy of rotation K_{rot} is given by Eq. (10) where the value of the electron angular momentum L for the state $Y_{lm}(\theta,\phi)$ is given by Eq. (11). The Schrodinger equation solutions, Eq. (10) and Eq. (11), predict that the ground state electron has zero angular energy and zero angular momentum, respectively.

• The Schrodinger equation solution, Eq. (11), predicts that the ionized electron may have infinite angular momentum.

• The Schrodinger equation solutions, Eq. (10) and Eq. (11), predict that the excited state rotational energy levels are nondegenerate as a function of the ℓ quantum number even in the absence of an applied magnetic field, and the predicted energy is over six orders of magnitude of the observed nondegenerate energy in the presence of a magnetic field. In the absence of a magnetic field, no preferred direction exists. In this case, the ℓ quantum number is a function of the orientation of the atom with respect to an arbitrary coordinate system. Therefore, the nondegeneracy is nonsensical and violates conservation of angular momentum of the photon.

• The Schrodinger equation predicts that each of the functions that corresponds to a highly excited state electron is not integrable and can not be normalized; thus, each is infinite.

It is trivial to appreciate that SQM fails and does not provide for the degeneracy of the angular momentum and rotational energy in the absence of a magnetic field for the trial case that n=1 with l=0 versus l=1 in Eqs. (10-11).

Section 86

Examiner Souw further errs in arguing on Appendix pages 25-26 that:

> The Examiner also takes issue with applicant's removal of $Y_{0,0}$ out of the complete set of angular momentum eigenfunctions $Y_{L,m}$(è,ö). As known in the art, the solutions of an eigenvalue equation form altogether a complete set of eigenfunctions. By taking out $Y_{0,0}$ Applicant's incomplete set of $Y_{L,m}$(è,ö) (L,m>0) is now incapable of representing an arbitrary function of (è,ö), since it is a mathematical rule generally known in the art that an arbitrary function (emphasis on the arbitrary) can only be represented by a complete set of eigenfunctions with all possible values of L, from L=0 to L=8. Thus L=0 cannot be taken out, as done by Applicant. In view of these serious misunderstandings by the applicant, applicant's arguments on angular momentum and spin are unpersuasive.

Applicant does not take Y0,0 out, as shown in Section 84 above and Chp 1 of Mills GUT, while SQM does. It has no rotational energy corresponding to spin angular momentum; yet, it has infinite energy io the electron's magnetic moment of a Bohr magneton.

Section 87

On page 26 of his Appendix, Examiner Souw further argues, erroneously, that:

> Still on pg.55, Applicant's statement *"the Examiner's requirement of taking linear combinations of eigenfunctions to result in a wavefunction solution to **avoid violating** the Uncertainty Principle* ", is another example of Applicant's misunderstanding of the Uncertainty Principle, as once again manifested on pg.65 of the amendment discussed below. Either a superposition of eigenfunctions, or a single eigenfunction, are **both** valid manifestations of the Uncertainty Principle, äp?äx?? or äL?äö??, for any two complementary observables. **None** of them violates the Uncertainty

Principle, as contended by Applicant. See also the same conceptual mistake in sub-paragraph 6(d) below.

This failure of SQM is discussed in Ref. #80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted, and in Section 85 above.

Section 88

Examiner Souw's erroneous analysis is further exposed by his statements on pages 26-27 of his Appendix:

> (c) Applicant's angular momentum wave functions as postulated (but not derived) in the GUT and repeated on pg.58-64 are mathematically flawed, since they contain mathematical inconsistencies and self-contradictions, as discussed in previous Souw Appendix (sect.6/pg.5-7). Accordingly, Applicant's argument regarding this subject matter is unpersuasive. As pointed out in the previous Appendix (sections 6-8 on pgs. 5-9), Applicant is representing both the spin function ($Y_{o,o}$) and the orbital momentum function ($Y_{l,,m}$, hereinafter denoted by $Y_{L,m}$) in the same space (***r***,t), i.e., as a single function $Y = Y_{o,o} + Y_{L,m}$ (see GUT, Eqs.I.61-1.65). This is a direct contradiction to Applicant's arguments in his present Response, recited on pg.57, (citation:) *"It is physically correct and mathematically correct to solve spin and orbital functions independently since there is no a priori reason, why they have to be a single eigenfunction or product **[sic!]** of eigenfunctions. After all, they are independent physical phenomena. The two dimensional wave equation plus time is given by McQuarrie* [1]").
>
> Most of this statement has been being practiced in science all the time by those ordinarily skilled in the art, except for one which is denoted with ***"[sic!]"***. However, Applicant has obviously misinterpreted his own statement, based on Applicant's own cited reference, i.e., McQuarrie [1] for reasons given in the next paragraph.

The Examiner is trying to fit a square peg in a round hole and insisting that Applicant must do likewise. Applicant has derived the angular momentum of the bound

electron from first principles. The Examiner relies on SQM's weird nonphysical probability wave that moves, but has no rotational energy, which is nonsense.

Applicant's derivations are given in Chp. 1 of Mills GUT. The results are used in 100's of calculations that agree remarkably with experiments as shown in Sections 54-55 and 69-70 above and in the following papers:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

Thus, once again Applicant has shown the Examiner to be in error. A summary of the correct way to derive the spin and orbital charge-density functions and corresponding angular momenta and energies is taken from:

106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted is given below:

A. One-Electron Atoms

One-electron atoms include the hydrogen atom, He^{+}, Li^{2+}, Be^{3+}, and so on. The mass-energy and angular momentum of the electron are constant; this requires that the equation of motion of the electron be temporally and spatially harmonic. Thus, the classical wave equation applies and

$$\left[\nabla^2 - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]\rho(r,\theta,\phi,t) = 0 \quad (2)$$

where $\rho(r,\theta,\phi,t)$ is the time dependent charge density function of the electron in time and space. In general, the wave equation has an infinite number of solutions. To arrive at the solution which represents the electron, a suitable boundary condition must be imposed. It is well known from experiments that each single atomic electron of a given isotope radiates to the same stable state. Thus, the physical boundary condition of nonradiation of the bound electron was imposed on the solution of the wave equation for the time dependent charge density function of the electron [1-3, 5]. The condition for radiation by a moving point charge given by Haus [26] is that its spacetime Fourier transform does possess components that are synchronous with waves traveling at the speed of light. Conversely, it is proposed that the condition for nonradiation by an ensemble of moving point charges that comprises a current density function is

For non-radiative states, the current-density function must NOT possess spacetime Fourier components that are synchronous with waves traveling at the speed of light.

The time, radial, and angular solutions of the wave equation are separable. The motion is time harmonic with frequency ω_n. A constant angular function is a solution to the wave equation. Solutions of the Schrödinger wave equation comprising a radial function radiate according to Maxwell's equation as shown previously by application of Haus' condition [1]. In fact, it was found that any function which permitted radial motion gave rise to radiation. A radial function which does satisfy the boundary condition is a radial delta function

$$f(r) = \frac{1}{r^2}\delta(r - r_n) \quad (3)$$

This function defines a constant charge density on a spherical shell where $r_n = nr_1$ wherein n is an integer in an excited state, and Eq. (2) becomes the two-dimensional wave equation plus time with separable time and angular functions. Given time harmonic motion and a radial delta function, the relationship between an allowed radius and the electron wavelength is given by

$$2\pi r_n = \lambda_n \quad (4)$$

where the integer subscript n here and in Eq. (3) is determined during photon absorption as given in the Excited States of the One-Electron Atom (Quantization) section of Ref. [1]. Using the observed de Broglie relationship for the electron mass where the coordinates are spherical,

$$\lambda_n = \frac{h}{p_n} = \frac{h}{m_e v_n} \quad (5)$$

and the magnitude of the velocity for *every* point on the orbitsphere is

$$v_n = \frac{\hbar}{m_e r_n} \quad (6)$$

The sum of the $|\mathbf{L}_i|$, the magnitude of the angular momentum of each infinitesimal point of the orbitsphere of mass m_i, must be constant. The constant is $\hbar$.

$$\sum |\mathbf{L}_i| = \sum |\mathbf{r} \times m_i \mathbf{v}| = m_e r_n \frac{\hbar}{m_e r_n} = \hbar \quad (7)$$

Thus, an electron is a spinning, two-dimensional spherical surface (zero thickness), called an *electron orbitsphere* shown in Figure 1, that can exist in a bound state at only specified distances from the nucleus determined by an energy minimum. The corresponding current function shown in Figure 2 which gives rise to the phenomenon of *spin* is derived in the Spin Function section. (See the Orbitsphere Equation of Motion for $\ell = 0$ of Ref. [1] at Chp. 1.)

Nonconstant functions are also solutions for the angular functions. To be a harmonic solution of the wave equation in spherical coordinates, these angular functions must be spherical harmonic functions [28]. A zero of the spacetime Fourier transform of the product function of two spherical harmonic angular functions, a time harmonic function, and an unknown radial function is sought. The solution for the radial function which satisfies the boundary condition is also a delta function given by Eq. (3). Thus, bound electrons are described by a charge-density (mass-density) function which is the product of a radial delta function, two angular functions (spherical harmonic functions), and a time harmonic function.

$$\rho(r,\theta,\phi,t) = f(r)A(\theta,\phi,t) = \frac{1}{r^2}\delta(r - r_n)A(\theta,\phi,t); \qquad A(\theta,\phi,t) = Y(\theta,\phi)k(t) \quad (8)$$

In these cases, the spherical harmonic functions correspond to a traveling charge density wave confined to the spherical shell which gives rise to the phenomenon of orbital angular momentum. The orbital functions which modulate the constant "spin" function shown graphically in Figure 3 are given in the Sec. IIC.

B. Spin Function

The orbitsphere spin function comprises a constant charge (current) density function with moving charge confined to a two-dimensional spherical shell. The magnetostatic current pattern of the orbitsphere spin function comprises an infinite series of correlated orthogonal great circle current loops wherein each point charge (current) density element moves time harmonically with constant angular velocity

$$\omega_n = \frac{\hbar}{m_e r_n^2} \quad (9)$$

The uniform current density function $Y_0^0(\phi,\theta)$, the orbitsphere equation of motion of the electron (Eqs. (14-15)), corresponding to the constant charge function of the orbitsphere that gives rise to the spin of the electron is generated from a basis set current-vector field defined as the orbitsphere current-vector field ("orbitsphere-cvf"). This in turn is generated over the surface by two complementary steps of an infinite series of nested rotations of two orthogonal great circle current loops where the coordinate axes rotate with the two orthogonal great circles that serve as a basis set. The algorithm to generate the current density function rotates the great circles and the corresponding x'y'z' coordinates relative to the xyz frame. Each infinitesimal rotation of the infinite series is about the new i'-axis and new j'-axis which results from the preceding such rotation. Each element of the current density function is obtained with each conjugate set of rotations. In Appendix III of Ref. [1], the *continuous* uniform electron current density function $Y_0^0(\phi,\theta)$ having the same angular momentum components as that of the orbitsphere-cvf is then exactly generated from this orbitsphere-cvf as a basis element by a convolution operator comprising an autocorrelation-type function.

For Step One, the current density elements move counter clockwise on the great circle in the y'z'-plane and move clockwise on the great circle in the x'z'-plane. The great circles are rotated by an infinitesimal angle $\pm\Delta\alpha_{i'}$ (a positive rotation around the x'-axis or a negative rotation about the z'-axis for Steps One and Two, respectively) and then by $\pm\Delta\alpha_{j'}$ (a positive rotation around the new y'-axis or a positive rotation about the new x'-axis for Steps One and Two, respectively). The coordinates of each point on each rotated great circle (x',y',z') is

expressed in terms of the first (x,y,z) coordinates by the following transforms where clockwise rotations and motions are defined as positive looking along the corresponding axis:

Step One

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_y) & 0 & -\sin(\Delta\alpha_y) \\ 0 & 1 & 0 \\ \sin(\Delta\alpha_y) & 0 & \cos(\Delta\alpha_y) \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ 0 & -\sin(\Delta\alpha_x) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_y) & \sin(\Delta\alpha_y)\sin(\Delta\alpha_x) & -\sin(\Delta\alpha_y)\cos(\Delta\alpha_x) \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ \sin(\Delta\alpha_y) & -\cos(\Delta\alpha_y)\sin(\Delta\alpha_x) & \cos(\Delta\alpha_y)\cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

(10)

Step Two

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\Delta\alpha_x) & \sin(\Delta\alpha_x) \\ 0 & -\sin(\Delta\alpha_x) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} \cos(\Delta\alpha_z) & \sin(\Delta\alpha_z) & 0 \\ -\sin(\Delta\alpha_z) & \cos(\Delta\alpha_z) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos(\Delta\alpha_z) & \sin(\Delta\alpha_z) & 0 \\ -\cos(\Delta\alpha_x)\sin(\Delta\alpha_z) & \cos(\Delta\alpha_x)\cos(\Delta\alpha_z) & \sin(\Delta\alpha_x) \\ \sin(\Delta\alpha_x)\sin(\Delta\alpha_z) & -\sin(\Delta\alpha_x)\cos(\Delta\alpha_z) & \cos(\Delta\alpha_x) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} \tag{11}$$

where the angular sum is $\lim_{\Delta\alpha \to 0} \sum_{n=1}^{\frac{\frac{\sqrt{2}}{2}\pi}{|\Delta\alpha_{i',j'}|}} |\Delta\alpha_{i',j'}| = \frac{\sqrt{2}}{2}\pi$.

The orbitsphere-cvf is given by n reiterations of Eqs. (10) and (11) for each point on each of the two orthogonal great circles during each of Steps One and Two. The output given by the non-primed coordinates is the input of the next iteration corresponding to each successive nested rotation by the infinitesimal angle $\pm\Delta\alpha_{i'}$ or $\pm\Delta\alpha_{j'}$ where the magnitude of the angular sum of the n rotations about each of the i'-axis and the j'-axis is $\frac{\sqrt{2}}{2}\pi$. Half of the orbitsphere-cvf is generated during each of Steps One and Two.

Following Step Two, in order to match the boundary condition that the magnitude of the velocity at any given point on the surface is given by Eq. (6), the output half of the orbitsphere-cvf is rotated clockwise by an angle of $\frac{\pi}{4}$ about the z-axis. Using Eq. (11) with $\Delta\alpha_{z'} = \frac{\pi}{4}$ and $\Delta\alpha_{x'} = 0$ gives the rotation. Then, the one half of the orbitsphere-cvf generated from Step One is superimposed with the complementary half obtained from Step Two following its rotation about the z-axis of $\frac{\pi}{4}$ to give the basis

function to generate $Y_0^0(\phi,\theta)$, the orbitsphere equation of motion of the electron.

The current pattern of the orbitsphere-cvf generated by the nested rotations of the orthogonal great circle current loops is a continuous and total coverage of the spherical surface, but it is shown as a visual representation using 6 degree increments of the infinitesimal angular variable $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ of Eqs. (10) and (11) from the perspective of the z-axis in Figure 2. In each case, the complete orbitsphere-cvf current pattern corresponds all the orthogonal-great-circle elements which are generated by the rotation of the basis-set according to Eqs. (10) and (11) where $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ approach zero and the summation of the infinitesimal angular rotations of $\pm\Delta\alpha_{i'}$ and $\pm\Delta\alpha_{j'}$ about the successive i'-axes and j'-axes is $\frac{\sqrt{2}}{2}\pi$ for each Step. The current pattern gives rise to the phenomenon corresponding to the spin quantum number. The details of the derivation of the spin function are given in Ref. [3] and Chp. 1 of Ref. [1].

The resultant angular momentum projections of $\mathbf{L}_{xy}=\frac{\hbar}{4}$ and $\mathbf{L}_z=\frac{\hbar}{2}$ meet the boundary condition for the unique current having an angular velocity magnitude at each point on the surface given by Eq. (6) and give rise to the Stern Gerlach experiment as shown in Ref. [1]. The further constraint that the current density is uniform such that the charge density is uniform, corresponding to an equipotential, minimum energy surface is satisfied by using the orbitsphere-cvf as a basis element to generate $Y_0^0(\phi,\theta)$ using a convolution operator comprising an autocorrelation-type function as given in Appendix III of Ref. [1]. The operator comprises the convolution of each great circle current loop of the orbitsphere-cvf designated as the primary orbitsphere-cvf with a second orbitsphere-cvf designated as the secondary orbitsphere-cvf wherein the convolved secondary elements are matched for orientation, angular momentum, and phase to those of the primary. The resulting exact uniform current distribution obtained from the convolution has the same angular momentum distribution, resultant, $\mathbf{L_R}$, and components of $\mathbf{L}_{xy}=\frac{\hbar}{4}$ and $\mathbf{L}_z=\frac{\hbar}{2}$ as those of the orbitsphere-cvf used as a primary basis element.

C. Angular Functions

The time, radial, and angular solutions of the wave equation are separable. Also based on the radial solution, the angular charge and

current-density functions of the electron, $A(\theta, \phi, t)$, must be a solution of the wave equation in two dimensions (plus time),

$$\left[\nabla^2 - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]A(\theta,\phi,t) = 0 \quad (12)$$

where $\rho(r,\theta,\phi,t) = f(r)A(\theta,\phi,t) = \frac{1}{r^2}\delta(r - r_n)A(\theta,\phi,t)$ and $A(\theta,\phi,t) = Y(\theta,\phi)k(t)$

$$\left[\frac{1}{r^2 \sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right)_{r,\phi} + \frac{1}{r^2\sin^2\theta}\left(\frac{\partial^2}{\partial\phi^2}\right)_{r,\theta} - \frac{1}{v^2}\frac{\partial^2}{\partial t^2}\right]A(\theta,\phi,t) = 0 \quad (13)$$

where v is the linear velocity of the electron. The charge-density functions including the time-function factor are

$\ell = 0$

$$\rho(r,\theta,\phi,t) = \frac{e}{8\pi r^2}[\delta(r - r_n)]\left[Y_0^0(\theta,\phi) + Y_\ell^m(\theta,\phi)\right] \quad (14)$$

$\ell \neq 0$

$$\rho(r,\theta,\phi,t) = \frac{e}{4\pi r^2}[\delta(r - r_n)]\left[Y_0^0(\theta,\phi) + \operatorname{Re}\left\{Y_\ell^m(\theta,\phi)e^{i\omega_n t}\right\}\right] \quad (15)$$

where $Y_\ell^m(\theta,\phi)$ are the spherical harmonic functions that spin about the z-axis with angular frequency ω_n with $Y_0^0(\theta,\phi)$ the constant function. $\operatorname{Re}\left\{Y_\ell^m(\theta,\phi)e^{i\omega_n t}\right\} = P_\ell^m(\cos\theta)\cos(m\phi + \omega_n' t)$ where to keep the form of the spherical harmonic as a traveling wave about the z-axis, $\omega_n' = m\omega_n$.

D. Acceleration without Radiation

a. Special Relativistic Correction to the Electron Radius

The relationship between the electron wavelength and its radius is given by Eq. (4) where λ is the de Broglie wavelength. For each current density element of the spin function, the distance along each great circle in the direction of instantaneous motion undergoes length contraction and time dilation. Using a phase matching condition, the wavelengths of the electron and laboratory inertial frames are equated, and the corrected radius is given by

$$r_n = r_n' \left[\sqrt{1-\left(\frac{v}{c}\right)^2} \sin\left[\frac{\pi}{2}\left(1-\left(\frac{v}{c}\right)^2\right)^{3/2}\right] + \frac{1}{2\pi}\cos\left[\frac{\pi}{2}\left(1-\left(\frac{v}{c}\right)^2\right)^{3/2}\right]\right] \quad (16)$$

where the electron velocity is given by Eq. (6). (See Ref. [1] Chp. 1, Special Relativistic Correction to the Ionization Energies section). $\frac{e}{m_e}$ of the electron, the electron angular momentum of $\hbar$, and μ_B are invariant, but the mass and charge densities increase in the laboratory frame due to the relativistically contracted electron radius. As $v \to c$, $r/r' \to \frac{1}{2\pi}$ and $r = \lambda$ as shown in Figure 4.

b. Nonradiation Based on the Spacetime Fourier Transform of the Electron Current

The Fourier transform of the electron charge density function given by Eq. (8) is a solution of the three-dimensional wave equation in frequency space ($\mathbf{k},\omega\, space$) as given in Chp 1, Spacetime Fourier Transform of the Electron Function section of Ref. [1]. Then the corresponding Fourier transform of the current density function $K(s,\Theta,\Phi,\omega)$ is given by multiplying by the constant angular frequency.

$$K(s,\Theta,\Phi,\omega) = 4\pi\omega_n \frac{\sin(2s_n r_n)}{2s_n r_n} \otimes 2\pi \sum_{\upsilon=1}^{\infty} \frac{(-1)^{\upsilon-1}(\pi\sin\Theta)^{2(\upsilon-1)}}{(\upsilon-1)!(\upsilon-1)!} \frac{\Gamma\left(\frac{1}{2}\right)\Gamma\left(\upsilon+\frac{1}{2}\right)}{(\pi\cos\Theta)^{2\upsilon+1}2^{\upsilon+1}} \frac{2\upsilon!}{(\upsilon-1)!} s^{-2\upsilon}$$
$$\otimes 2\pi \sum_{\upsilon=1}^{\infty} \frac{(-1)^{\upsilon-1}(\pi\sin\Phi)^{2(\upsilon-1)}}{(\upsilon-1)!(\upsilon-1)!} \frac{\Gamma\left(\frac{1}{2}\right)\Gamma\left(\upsilon+\frac{1}{2}\right)}{(\pi\cos\Phi)^{2\upsilon+1}2^{\upsilon+1}} \frac{2\upsilon!}{(\upsilon-1)!} s^{-2\upsilon} \frac{1}{4\pi}[\delta(\omega-\omega_n)+\delta(\omega+\omega_n)] \quad (17)$$

$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n$ implies $r_n = \lambda_n$ which is given by Eq. (16) in the case that k is the lightlike k^0. In this case, Eq. (17) vanishes. Consequently, spacetime harmonics of $\frac{\omega_n}{c} = k$ or $\frac{\omega_n}{c}\sqrt{\frac{\varepsilon}{\varepsilon_o}} = k$ for which the Fourier transform of the current-density function is nonzero do not exist. Radiation due to charge motion does not occur in any medium when this boundary condition is met. Nonradiation is also determined directly from the fields based on Maxwell's equations as given in Sec. IIDc.

c. Nonradiation Based on the Electron Electromagnetic Fields and the Poynting Power Vector

A point charge undergoing periodic motion accelerates and as a consequence radiates according to the Larmor formula:

$$P = \frac{1}{4\pi\varepsilon_0}\frac{2e^2}{3c^3}a^2 \quad (18)$$

where e is the charge, a is its acceleration, ε_0 is the permittivity of free space, and c is the speed of light. Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate [21, 26, 29-31]. In Ref. [3] and Appendix I, Chp. 1 of Ref. [1], the electromagnetic far field is determined from the current distribution in order to obtain the condition, if it exists, that the electron current distribution must satisfy such that the electron does not radiate. The current follows from Eqs. (14-15). The currents corresponding to Eq. (14) and first term of Eq. (15) are static. Thus, they are trivially nonradiative. The current due to the time dependent term of Eq. (15) corresponding to p, d, f, etc. orbitals is

$$\begin{aligned}\mathbf{J} &= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2}N[\delta(r-r_n)]\mathrm{Re}\{Y_\ell^m(\theta,\phi)\}[\mathbf{u}(t)\times\mathbf{r}] \\ &= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2}N'[\delta(r-r_n)]\left(P_\ell^m(\cos\theta)\cos(m\phi+\omega_n' t)\right)[\mathbf{u}\times\mathbf{r}] \quad (19) \\ &= \frac{\omega_n}{2\pi}\frac{e}{4\pi r_n^2}N'[\delta(r-r_n)]\left(P_\ell^m(\cos\theta)\cos(m\phi+\omega_n' t)\right)\sin\theta\hat{\phi}\end{aligned}$$

where to keep the form of the spherical harmonic as a traveling wave about the z-axis, $\omega_n' = m\omega_n$ and N and N' are normalization constants. The vectors are defined as

$$\hat{\phi} = \frac{\hat{u}\times\hat{r}}{|\hat{u}\times\hat{r}|} = \frac{\hat{u}\times\hat{r}}{\sin\theta}; \qquad \hat{u} = \hat{z} = orbital\ axis \quad (20)$$

$$\hat{\theta} = \hat{\phi}\times\hat{r} \quad (21)$$

"^" denotes the unit vectors $\hat{u} \equiv \frac{\mathbf{u}}{|\mathbf{u}|}$, non-unit vectors are designed in bold, and the current function is normalized. For the electron source current given by Eq. (19), each comprising a multipole of order (ℓ,m) with a time dependence $e^{i\omega_n t}$, the far-field solutions to Maxwell's equations are given by

$$\begin{aligned}\mathbf{B} &= -\frac{i}{k}a_M(\ell,m)\nabla\times g_\ell(kr)\mathbf{X}_{\ell.m} \\ \mathbf{E} &= a_M(\ell,m)g_\ell(kr)\mathbf{X}_{\ell.m}\end{aligned} \quad (22)$$

and the time-averaged power radiated per solid angle $\frac{dP(\ell,m)}{d\Omega}$ is

$$\frac{dP(\ell,m)}{d\Omega}=\frac{c}{8\pi k^2}\left|a_M(\ell,m)\right|^2\left|\mathbf{X}_{\ell,m}\right|^2 \quad (23)$$

where $a_M(\ell,m)$ is

$$a_M(\ell,m)=\frac{-ek^2}{c\sqrt{\ell(\ell+1)}}\frac{\omega_n}{2\pi}Nj_\ell(kr_n)\Theta\sin(mks) \quad (24)$$

In the case that k is the lightlike k^0, then $k=\omega_n/c$, in Eq. (24), and Eqs. (22-23) vanishes for

$$s=vT_n=R=r_n=\lambda_n \quad (25)$$

There is no radiation.

E. Magnetic Field Equations of the Electron

The orbitsphere is a shell of negative charge current comprising correlated charge motion along great circles. For ℓ = 0, the orbitsphere gives rise to a magnetic moment of 1 Bohr magneton [32]. (The details of the derivation of the magnetic parameters including the electron g factor are given in Ref. [3] and Chp. 1 of Ref. [1].)

$$\mu_B=\frac{e\hbar}{2m_e}=9.274\,X\,10^{-24}\,JT^{-1} \quad (26)$$

The magnetic field of the electron shown in Figure 5 is given by

$$\mathbf{H}=\frac{e\hbar}{m_e r_n^3}(\mathbf{i}_r\cos\theta-\mathbf{i}_\theta\sin\theta) \qquad \text{for } r<r_n \quad (27)$$

$$\mathbf{H}=\frac{e\hbar}{2m_e r^3}(\mathbf{i}_r 2\cos\theta+\mathbf{i}_\theta\sin\theta) \qquad \text{for } r>r_n \quad (28)$$

The energy stored in the magnetic field of the electron is

$$E_{mag}=\frac{1}{2}\mu_o\int_0^{2\pi}\int_0^{\pi}\int_0^{\infty}H^2r^2\sin\theta dr d\theta d\Phi \quad (29)$$

$$E_{mag\ \mathrm{total}}=\frac{\pi\mu_o e^2\hbar^2}{m_e^{\ 2}r_1^{\ 3}} \quad (30)$$

F. Stern-Gerlach Experiment

The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s ($s=\frac{1}{2}$; $m_s=\pm\frac{1}{2}$). The superposition of the vector projection of the orbitsphere angular momentum on the z-axis is $\frac{\hbar}{2}$ with an orthogonal component of $\frac{\hbar}{4}$. Excitation of a resonant Larmor precession gives rise to

$\hbar$ on an axis $\mathbf{S}$ that precesses about the z-axis called the spin axis at the Larmor frequency at an angle of $\theta = \frac{\pi}{3}$ to give a perpendicular projection of

$$\mathbf{S}_{\perp} = \hbar \sin\frac{\pi}{3} = \pm\sqrt{\frac{3}{4}}\hbar\, \mathbf{i}_{Y_R} \quad (31)$$

and a projection onto the axis of the applied magnetic field of

$$\mathbf{S}_{\parallel} = \hbar \cos\frac{\pi}{3} = \pm\frac{\hbar}{2}\mathbf{i}_z \quad (32)$$

The superposition of the $\frac{\hbar}{2}$, z-axis component of the orbitsphere angular momentum and the $\frac{\hbar}{2}$, z-axis component of $\mathbf{S}$ gives $\hbar$ corresponding to the observed electron magnetic moment of a Bohr magneton, μ_B.

G. Electron g Factor

Conservation of angular momentum of the orbitsphere permits a discrete change of its “kinetic angular momentum” $(\mathbf{r} \times m\mathbf{v})$ by the applied magnetic field of $\frac{\hbar}{2}$, and concomitantly the “potential angular momentum” $(\mathbf{r} \times e\mathbf{A})$ must change by $-\frac{\hbar}{2}$.

$$\Delta \mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \quad (33)$$

$$= \left[\frac{\hbar}{2} - \frac{e\phi}{2\pi}\right]\hat{z} \quad (34)$$

In order that the change of angular momentum, $\Delta\mathbf{L}$, equals zero, ϕ must be $\Phi_0 = \frac{h}{2e}$, the magnetic flux quantum. The magnetic moment of the electron is parallel or antiparallel to the applied field only. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla \bullet (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right] - \frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right] - \mathbf{J} \bullet \mathbf{E} \quad (35)$$

Eq. (36) gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively,

$$\Delta E_{mag}^{spin} = 2\left(1 + \frac{\alpha}{2\pi} + \frac{2}{3}\alpha^2\left(\frac{\alpha}{2\pi}\right) - \frac{4}{3}\left(\frac{\alpha}{2\pi}\right)^2\right)\mu_B B \quad (36)$$

$$\Delta E_{mag}^{spin} = g\mu_B B \quad (37)$$

where the stored magnetic energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right]$ term increases, the stored electric energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right]$ term increases, and the $\mathbf{J} \bullet \mathbf{E}$ term is dissipative. The spin-flip transition can be considered as involving a magnetic moment of g times that of a Bohr magneton. The g factor is redesignated the fluxon g factor as opposed to the anomalous g factor. Using $\alpha^{-1} = 137.03603(82)$, the calculated value of $\frac{g}{2}$ is $1.001\ 159\ 652\ 137$. The experimental value [33] of $\frac{g}{2}$ is $1.001\ 159\ 652\ 188(4)$.

H. Spin and Orbital Parameters

The total function that describes the spinning motion of each electron orbitsphere is composed of two functions. One function, the spin function, is spatially uniform over the orbitsphere, spins with a quantized angular velocity, and gives rise to spin angular momentum. The other function, the modulation function, can be spatially uniform—in which case there is no orbital angular momentum and the magnetic moment of the electron orbitsphere is one Bohr magneton—or not spatially uniform—in which case there is orbital angular momentum. The modulation function also rotates with a quantized angular velocity.

The spin function of the electron corresponds to the nonradiative $n = 1$, $\ell = 0$ state of atomic hydrogen which is well known as an s state or orbital. (See Figure 1 for the charge function and Figure 2 for the current function.) In cases of orbitals of heavier elements and excited states of one electron atoms and atoms or ions of heavier elements with the ℓ quantum number not equal to zero and which are not constant as given by Eq. (14), the constant spin function is modulated by a time and spherical harmonic function as given by Eq. (15) and shown in Figure 3. The modulation or traveling charge density wave corresponds to an orbital angular momentum in addition to a spin angular momentum. These states are typically referred to as p, d, f, etc. orbitals. Application of Haus's [26] condition also predicts nonradiation for a constant spin function modulated by a time and spherically harmonic orbital function. There is acceleration without radiation as also shown in Sec. IIDc. (Also see Abbott and Griffiths, Goedecke, and Daboul and Jensen [29-31]). However, in the case that such a state arises as an excited state by

photon absorption, it is radiative due to a radial dipole term in its current density function since it possesses spacetime Fourier Transform components synchronous with waves traveling at the speed of light [26]. (See Instability of Excited States section of Ref. [1].)

a. Moment of Inertia and Spin and Rotational Energies

The moments of inertia and the rotational energies as a function of the ℓ quantum number for the solutions of the time-dependent electron charge density functions (Eqs. (14-15)) given in Sec. IIC are solved using the rigid rotor equation [28]. The details of the derivations of the results as well as the demonstration that Eqs. (14-15) with the results given *infra.* are solutions of the wave equation are given in Chp 1, Rotational Parameters of the Electron (Angular Momentum, Rotational Energy, Moment of Inertia) section of Ref. [1].

$\ell = 0$

$$I_z = I_{spin} = \frac{m_e r_n^2}{2} \quad (38)$$

$$L_z = I\omega \mathbf{i}_z = \pm\frac{\hbar}{2} \quad (39)$$

$$E_{rotational} = E_{rotational,\,spin} = \frac{1}{2}\left[I_{spin}\left(\frac{\hbar}{m_e r_n^2}\right)^2\right] = \frac{1}{2}\left[\frac{m_e r_n^2}{2}\left(\frac{\hbar}{m_e r_n^2}\right)^2\right] = \frac{1}{4}\left[\frac{\hbar^2}{2I_{spin}}\right] \quad (40)$$

$$T = \frac{\hbar^2}{2m_e r_n^2} \quad (41)$$

$\ell \neq 0$

$$I_{orbital} = m_e r_n^2\left[\frac{\ell(\ell+1)}{\ell^2+2\ell+1}\right]^{\frac{1}{2}} = m_e r_n^2\sqrt{\frac{\ell}{\ell+1}} \quad (42)$$

$$\mathbf{L} = I\omega\mathbf{i}_z = I_{orbital}\omega\mathbf{i}_z = m_e r_n^2\left[\frac{\ell(\ell+1)}{\ell^2+2\ell+1}\right]^{\frac{1}{2}}\omega\mathbf{i}_z = m_e r_n^2\frac{\hbar}{m_e r_n^2}\sqrt{\frac{\ell}{\ell+1}} = \hbar\sqrt{\frac{\ell}{\ell+1}} \quad (43)$$

$$L_{z\,total} = L_{z\,spin} + L_{z\,orbital} \quad (44)$$

$$E_{rotational\ \mathrm{orbital}} = \frac{\hbar^2}{2I}\left[\frac{\ell(\ell+1)}{\ell^2+2\ell+1}\right] = \frac{\hbar^2}{2I}\left[\frac{\ell}{\ell+1}\right] = \frac{\hbar^2}{2m_e r_n^2}\left[\frac{\ell}{\ell+1}\right] \quad (45)$$

$$\langle L_{z\,orbital}\rangle = 0 \quad (46)$$

$$\langle E_{rotational\ \mathrm{orbital}}\rangle = 0 \quad (47)$$

The orbital rotational energy arises from a spin function (spin angular momentum) modulated by a spherical harmonic angular function (orbital angular momentum). The time-averaged mechanical angular momentum and rotational energy associated with the wave-equation solution comprising a traveling charge-density wave on the orbitsphere is zero as given in Eqs. (46) and (47), respectively. Thus, the principal levels are degenerate except when a magnetic field is applied. In the case of an excited state, the angular momentum of $\hbar$ is carried by the fields of the trapped photon. The amplitudes that couple to external magnetic and electromagnetic fields are given by Eq. (43) and (45), respectively. The rotational energy due to spin is given by Eq. (40), and the total kinetic energy is given by Eq. (41).

Section 89

Examiner Souw argues on page 27 of the Appendix that:

(c. 1) Firstly, McQuarrie's spin-orbital eigenfunction $\phi_{100\pm}$ as defined in Eqs.8-50 and 8-5 1, is a product of the orbital eigenfunction ϕ_{100} (see Table 6-5 on pg. 224) and the spin eigenfunction á and/or â, the latter defined independently by Eqs. 8-43 and 8-46. In contradiction to Applicant's misunderstanding, it is just because it is product, can the resulting wavefunction remain an eigenfunction of both the angular and the spin operators! Thus, that part of Applicant's statement denoted by ***[sic!]*** is fundamentally incorrect.

Once again, the Examiner simply argues the experimentally proven-wrong approach of SQM. Applicant uses the correct approach based on physical laws as given in Sections 82-88 above.

Section 90

Examiner Souw merely continues to make the same analysis errors in his argument on Appendix pages 27-28:

(c.2) Secondly, Applicant's new statement cited above is a contradiction to Applicant's angular momentum (spin-orbital) wave function given in GUT, Eqs. 1.61-1.65, in which the spin wavefunction ($Y_{0,0}$) and the orbital wavefunction ($Y_{L,m}$) are both solutions of the same equation, and represented by one spin-orbital function in the form of an addition of two

> functions in the <u>same</u> and <u>single</u> *(r,t)* space, i.e., $YY_{0,0}+Y_{L,m}$, but <u>not</u> in two independent functions, ø=ø?á and ø=ø?â as correctly stated by McQuarrie in Eq. 8-50. What Applicant would mean with McQuarrie's *"two dimensional wave equation"* has its solution defined in a two-dimensional space as a (2-dimensional vector) functions á and â defined in McQuarrie's Eq. 8-43. These á and â are known in the art as representing two linearly independent eigenfunctions, or basis vectors, that can (but not must) be conveniently represented by á=[1,0] and â=[0, 1], which are obviously orthogonal for satisfying the orthogonality condition in Eq.8-46 on pg.300, and yet <u>fully different than -- and fully independent of-- the ordinary space</u> (***r***,t). (<u>Note</u>: *As generally known in the art, McQuarrie's orthogonality condition in the form of integrals over a not further-specified spin variable ó (Eq.8-46) is greatly simplified by defining --with Pauli— the spin functions á and â in its equivalent vector form,* **á** *and* **â**, *which is mathematically more elegant and also conventional).* In contrast, although Applicant's $Y_{0,0}$ is constant, it is still a function defined in the <u>same</u> and <u>single</u> space(***r***,t) as $Y_{L,m}$, and hence, <u>does not comply with Applicant's own new statement.</u>

The Examiner simply doesn't get it. The rules of SQM may be taught in textbooks, but the results are <u>not</u> correct. Applicant has found a different physical path that overcomes the failures of the SQM approach. In other words, Applicant agrees with the Examiner that he is not following the mathematical postulates and rules of SQM. Rather, Applicant is deriving results based on physical laws. The agreement of predictions with observations show that SQM is wrong and CQM is right.

Applicant's solution for the spin function, which corresponds to a current, is in accord with physical laws. (This is opposed to the case of SQM, wherein the electron has current in zero dimensional space. This inescapable feature of SQM is nonsensical and corresponds to a further violation of physical laws in contradiction to the Examiner's insistence that he is following physical laws.) Superimposed on the CQM spin current is the independent spherically-harmonic charge-density wave that travels time-harmonically on the two-dimensional surface of the electron and modulates the constant spin function. The modulation function averages to zero; yet, it gives rise to orbital splitting in the presence of a magnetic field. The results match experiments

exactly in contrast to the SQM predictions. Modulation is a common physical phenomenon. Ripples on traveling fluid flow, air flow, etc., and AC modulation of a DC current are just some of the infinite physical possibilities. In all cases, the modulation occurs at the same positions in space as the constant term. Thus, the reason that the Examiner believes Applicant's use of CQM gives rise to a contradiction is that SQM is nonphysical and follows mathematical rules, which, by the Examiner's own analysis, demonstrates the impossibility of modulation of a constant parameter such as current. This further proves that SQM is nonphysical, purely mathematical, and not based in the reality of the physical world.

Section 91

Examiner Souw's erroneous analysis continues on pages 28-29 of his Appendix with the following misguided statements:

> (c.3) Thirdly, Applicant has misrepresented his own cited reference [1], the latter unambiguously reciting on pg.300, *"In a sense, á= $Y_{\_,+\_}$ and â= $Y_{\_,-\_}$, but this is strictly formal association, and á and â, and even $\mathbf{S}^2$ and $\mathbf{S}_Z$, for that matter, do not have to be specified any further."* Thus, it is principally incorrect to interpret $Y_{\_,\pm\_}$ as being the same orbital function $Y_{L,m}$, but with L=_ and m=±_. In fact, it is mathematically impossible to do so, simply because the (bounded) solution of the pertinent differential equation requires L to be an integer (see McQuarrie [1], Eq. 6-101). It is further recited on the next line," *The functions á and â in Eq.8-43 are called spin eigenfunctions" ...., which we write formally as* ..." followed by defining its orthonormal properties in Eq.8-46. As known in the art, it is sufficient and correct to define the spin functions á and â as in Eq. 8-43, together with their orthogonality condition as defined in Eq.8-46. Obviously, what is correctly meant by McQuarrie with $Y_{\_,\pm\_}$ *as formally* representing the spin functions á and â is not $Y_{0,0}$, as insisted by Applicant in his response and in his GUT (Eqs.1 .61-1.65). As generally known in the art what McQuarrie meant with á and â are the Pauli spin eigenfunctions, **á**[1,0] and **â**[0, 1], respectively, which are column vectors that should be rigorously written in columns, i.e., one component above the other (as used by the Examiner in his cited own work [3] as well by a

many other authors), instead of sequential rows, i.e., one component after the other.

It is trivial to show that inputting a constant to the two-dimensional wave equation plus time gives zero. Thus, a constant function is a solution. Applicant's spin function provides for the stability of the hydrogen atom, it is relativistically invariant, and it reproduces all aspects of electron spin.

It is time to discard all of the jargon, mathematical rules, nonphysical weirdness etc., such as Pauli spin eigenfunctions, **á**[1,0] and **â**[0, 1], respectively, which are column vectors that should be rigorously written in columns, i.e., one component above the other (as used by the Examiner in his cited own work [3] as well by a many other authors), instead of sequential rows, i.e., one component after the other.

This is not physics. The Schrodinger equation did not predict spin. Then, many other theoreticians, including Dirac, tried to solve the physical electron using Maxwell's equations to give rise to electron spin. This was an obvious issue as noted by Einstein:

You know, it would be sufficient to really understand the electron.

Albert Einstein

H. Dehmelt' "Experiments with an isolated subatomic particle at rest", Reviews of Modern Physics, Vol. 62, No. 3, (1990), pp. 525-530.

The current postulate of "inherent spin" is unsatisfactory. It has caused more problems than it was solved. It is easy to appreciate that the SQM picture is not predictive. There have been many failures of the SQM picture of the electron zero-dimensions. For example:

"They also laid to rest Wolfgang Pauli's assertions (3,6)—backed by Niels Bohr—that the spin magnetic moment of the electron could never be

measured on free electrons, that is, electrons not bound to a nucleus, by means of spin-dependent changes in classical orbits. [1]

1. H. Dehmelt, "Experiments on the Structure of an Individual Elementary Particle", Science, Vol. 234, (1990), pp. 539-554.

Even the title of the article according to SQM is an impossible situation:

H. Dehmelt' "Experiments with an isolated subatomic particle at rest", Reviews of Modern Physics, Vol. 62, No. 3, (1990), pp. 525-530.

Others failed to solve this problem and desperately resorted to the "intrinsic-spin" postulate. Applicant has solved the electron physically and the results work where SQM has failed. The approach is summarized in

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted:

III. Classical Quantum Theory of the Atom Based on Maxwell's Equations

In this paper, the old view that the electron is a zero or one-dimensional point in an all-space probability wave function $\Psi(x)$ is not taken for granted. The theory of classical quantum mechanics (CQM), derived from first principles, must successfully and consistently apply physical laws on all scales [2-10]. Stability to radiation was ignored by all past atomic models. Historically, the point at which QM broke with classical laws can be traced to the issue of nonradiation of the one electron atom. Bohr just postulated orbits stable to radiation with the further postulate that the bound electron of the hydrogen atom does not obey Maxwell's equations—rather it obeys different physics [2, 7]. Later physics was replaced by "pure mathematics" based on the notion of the inexplicable wave-particle duality nature of electrons which lead to the Schrödinger equation wherein the consequences of radiation predicted by Maxwell's equations were ignored. Ironically, Bohr, Schrödinger, and Dirac used the Coulomb potential, and Dirac used the

vector potential of Maxwell's equations. But, all ignored electrodynamics and the corresponding radiative consequences. Dirac originally attempted to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gave rise to electron spin [37]. He and many founders of QM such as Sommerfeld, Bohm, and Weinstein wrongly pursued a planetary model, were unsuccessful, and resorted to the current mathematical-probability-wave model that has many problems [1-10, 19, 22-23, 37]. Consequently, Feynman for example, attempted to use first principles including Maxwell's equations to discover new physics to replace quantum mechanics [38].

Physical laws may indeed be the root of the observations thought to be "purely quantum mechanical", and it may have been a mistake to make the assumption that Maxwell's electrodynamic equations must be rejected at the atomic level. Thus, in the present approach, the classical wave equation is solved with the constraint that a bound $n = 1$-state electron cannot radiate energy.

Herein, derivations consider the electrodynamic effects of moving charges as well as the Coulomb potential, and the search is for a solution representative of the electron wherein there is acceleration of charge motion without radiation. The mathematical formulation for zero radiation based on Maxwell's equations follows from a derivation by Haus [39]. The function that describes the motion of the electron must not possess spacetime Fourier components that are synchronous with waves traveling at the speed of light. Similarly, nonradiation is demonstrated based on the electron's electromagnetic fields and the Poynting power vector.

It was shown previously [3-8] that CQM gives closed form solutions for the atom including the stability of the $n = 1$ state and the instability of the excited states, the equation of the photon and electron in excited states, the equation of the free electron, and photon which predict the wave particle duality behavior of particles and light. The current and charge density functions of the electron may be directly physically interpreted. For example, spin angular momentum results from the motion of negatively charged mass moving systematically, and the equation for angular momentum, $\mathbf{r} \times \mathbf{p}$, can be applied directly to the wave function (a current density function) that describes the electron. The magnetic moment of a Bohr magneton, Stern Gerlach experiment, g factor, Lamb shift, resonant line width and shape, selection rules, correspondence principle, wave particle duality, excited states, reduced mass, rotational energies, and momenta, orbital and spin splitting, spin-orbital coupling, Knight shift, and spin-nuclear coupling, and elastic electron scattering from helium atoms, are derived in closed form equations based on Maxwell's equations. The calculations agree with experimental observations.

In contrast to the failure of the Bohr theory and the nonphysical, adjustable-parameter approach of quantum mechanics, multielectron atoms [4, 7] and the nature of the chemical bond [5, 7] are given by exact closed-form solutions containing fundamental constants only. Using the nonradiative wave equation solutions that describe each bound electron having conserved momentum and energy, the radii are determined from the force balance of the electric, magnetic, and centrifugal forces that correspond to the minimum of energy of the atomic or ionic system. The ionization energies are then given by the electric and magnetic energies at these radii. The spreadsheets to calculate the energies from exact solutions of one through twenty-electron atoms are available from the internet [40]. For 400 atoms and ions the agreement between the predicted and experimental results are remarkable.

<u>Section 92</u>

Pages 29-30 of the Souw Appendix contains the following additional errors in analysis:

This will now be mathematically proven by the Examiner in a rigorous manner. As recited in Ref. [3] already cited by the Examiner in the previous Appendix, and also in [6] as a new/independent reference (in order to convince Applicant that this Pauli matrix formulation is truly an <u>elementary</u> concept generally known to those <u>ordinary skilled</u> in the art), the Pauli spin operators are defined as (with ***bold italics*** denoting operators): ***S***$_X$= _/2 ***ó***$_X$, ***S***$_y$=_/2 ***ó***$_y$, ***S***$_Z$= _/2 ***ó***$_X$, and ***S***^{2}=_^{2}/4 ***ó***^{2}, with the Pauli spin matrices ***ó***$_X$, ***ó***$_y$, ***ó***$_Z$, and ***S***^{2} conventionally defined as

ó$_X$ =0 1   ó$_y$= 0 -i   ó$_Z$ = 1 0   and   ó^2 = ó$_X$^{2} + ó$_y$^{2} + ó$_Z$^{2}

1 0   i 0   0 -1

These Pauli spin matrices **ó** (the **bold** print denotes its vector character) <u>are not to be confused</u> with the unspecified spin variable a used by McQuarrie in Eqs. 8-46. The latter will not be further used, because it has not been (and cannot be, or does not need to be) further specified, and its role has 'been adequately taken over by the vectorial properties of the Pauli spin vectors **á** and **â**. Applying these operators to McQuarrie's spin functions á(ó) and â(ó), which are now conveniently and conventionally represented by á(ó)> **á**=[1,0] and â(ó) > **â**=[0,1], both

> defined as column vectors and both are eigenfunctions of both **ó**^{2} and ó$_Z$, we easily obtain in terms of rigorous undergraduate mathematics:
>
> ***S****$_Z$***á** = _/2 **ó$_Z$á** = + _/2 **á** ; ***S$_Z$* â ó$_Z$â** = -_/2 **â** ;and
>
> ***S^2*** **á**= _^{2}/4 **ó**^{2} **á** = _^{2}/4 (1+1+1) **á** = 3 _^{2}/4 **á** : as well as ***S^2*** **â**= _^{2}/4 **ó**^{2} **â** = _^{2}/4 (1+1+1) **â**
>
> The mathematical relations derived above are in complete agreement with the properties of McQuarrie's spin functions as defined in Eq.8-43. It has been thus proven that Applicant has misunderstood and misrepresented his own cited McQuarrie reference [1], as well as the conventional QM that traditionally makes use of Pauli spin matrices [3, 6].

Applicant does not follow the incorrect approach of SQM. Rather, he correctly solves the electron to give physical predictions that match the observations of the Stern Gerlach experiment. The object is to solve the physical problem correctly, not to follow in the deep rut of SQM mathematics that leads to the wrong physical solution. That the electron is solved correctly by Applicant using physical laws is confirmed by the fact that it is predictive. For example, Applicant's solution predicts the g factor, which is missed entirely by the Examiner's Pauli spin vectors.

In CQM, the g factor is given by a simple close-formed equation with fundamental constants only that is easily derived from the Poynting Power Theorem using the condition of conservation of angular momentum for the spin-flip transition.

ELECTRON g FACTOR

Conservation of angular momentum of the orbitsphere permits a discrete change of its "kinetic angular momentum" $(\mathbf{r} \times m\mathbf{v})$ by the applied magnetic field of $\frac{\hbar}{2}$, and concomitantly the "potential angular momentum" $(\mathbf{r} \times e\mathbf{A})$ must change by $-\frac{\hbar}{2}$.

$$\Delta \mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \qquad (3)$$

$$=\left[\frac{\hbar}{2}-\frac{e\phi}{2\pi}\right]\hat{z} \tag{4}$$

In order that the change of angular momentum, $\Delta\mathbf{L}$, equals zero, ϕ must be $\Phi_0=\frac{h}{2e}$, the magnetic flux quantum. The magnetic moment of the electron is parallel or antiparallel to the applied field only. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla\bullet(\mathbf{E}\times\mathbf{H})=-\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o\mathbf{H}\bullet\mathbf{H}\right]-\frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o\mathbf{E}\bullet\mathbf{E}\right]-\mathbf{J}\bullet\mathbf{E} \tag{5}$$

Eq. (6) gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively,

$$\Delta E_{mag}^{spin}=2\left(1+\frac{\alpha}{2\pi}+\frac{2}{3}\alpha^2\left(\frac{\alpha}{2\pi}\right)-\frac{4}{3}\left(\frac{\alpha}{2\pi}\right)^2\right)\mu_B B \tag{6}$$

$$\Delta E_{mag}^{spin}=g\mu_B B \tag{7}$$

where the stored magnetic energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o\mathbf{H}\bullet\mathbf{H}\right]$ term increases, the stored electric energy corresponding to the $\frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o\mathbf{E}\bullet\mathbf{E}\right]$ term increases, and the $\mathbf{J}\bullet\mathbf{E}$ term is dissipative. The spin-flip transition can be considered as involving a magnetic moment of g times that of a Bohr magneton. The g factor is redesignated the fluxon g factor as opposed to the anomalous g factor. Using $\alpha^{-1}=137.03603(82)$, the calculated value of $\frac{g}{2}$ is $\mathbf{1.001\ 159\ 652\ 137}$. The experimental value [1] of $\frac{g}{2}$ is $\mathbf{1.001\ 159\ 652\ 188(4)}$.

References for this section:

1. R. S. Van Dyck, Jr., P. Schwinberg, H. Dehmelt, "New high precision comparison of electron and positron g factors", Phys. Rev. Lett., Vol. 59, (1987), p. 26-29.

Section 93

Examiner Souw further errs in his analysis appearing on pages 30-31 of his Appendix:

> (c.4) Fourthly, on top of his misunderstanding, Applicant also has misrepresented his own McQuarrie reference by presenting $Y_{0,0}$ in place of McQuarrie's Y _,±_ spin functions, thus leaving an incomplete set of angular momentum eigenfunctions $Y_{L,m}$(è,ö) with L?1 by excluding $Y_{0,0}$. It is to be emphasized, McQuarrie's *formal* Y _,±_ is not (and never can be; therefore McQuarrie's stress on "formal") a solution of the angular momentum eigenvalue equation, as incorrectly assumed by Applicant by misrepresenting it as $Y_{0,0}$. McQuarrie's Y _,±_ is purely formal, and can never be a true or actual angular momentum eigenfunction, $Y_{L,m}$, in which both L and m must be integers, as generally known in the art (see also McQuarrie [1], Eq.6-101 for one-electron atom as well as Eq.6-61 for a diatomic molecule). As generally known in the art, by formally denoting the spin function with Y _,±_, McQuarrie's set of angular momentum eigenfunctions still includes the zero orbital eigenfunction, $Y_{0,0}$. As such, McQuarrie's set of orbital eigenfunctions remains intact as a complete set of eigenfunctions, as it must always be. Obviously, Applicant's set of orbital eigenfunctions fails to comply with his own reference [1], and furthermore, violates a fundamental law of mathematics.

Again, Applicant is NOT following an INCORRECT approach.

Specifically, in response to the Examiner's statement that "McQuarrie's *formal* Y _,±_ is not (and never can be; therefore McQuarrie's stress on "formal") a solution of the angular momentum eigenvalue equation, as incorrectly assumed by Applicant by misrepresenting it as $Y_{0,0}$. McQuarrie's," Applicant does not assert that the Y1/2 function is a solution of the angular momentum eigenvalue equation. Applicant solves for the spin function by applying physics to the following constraints on the current. From Chp. 1 Mills GUT (Ref. #1):

Stern-Gerlach-Experiment Boundary Conditions

It is known from the Stern-Gerlach experiment that a beam of silver atoms is split into two components when passed through an inhomogeneous magnetic field. This implies that the electron is a spin 1/2 particle with an intrinsic angular momentum in the direction of the applied field (spin axis) of $\pm\frac{\hbar}{2}$, and the magnitude of the angular momentum vector which precesses about the spin axis is $\sqrt{\frac{3}{4}}\hbar$. Furthermore, the magnitude of the splitting implies a magnetic moment of μ_B, a full Bohr magneton, given by Eq. (1.99) corresponding to $\hbar$ of total angular momentum on the axis of the applied field.

The algorithm to generate the $Y_0^{\,0}(\phi,\theta)$ orbitsphere equation of motion of the electron (Eqs. (1.64-1.65)) is developed in this section. It was shown in the Angular Function section that the integral of the magnitude of the angular momentum over the orbitsphere must be constant. The constant is $\hbar$ as given by Eq. (1.57). It is shown in this section that the projection of the intrinsic orbitsphere angular momentum onto the spin axis is $\pm\frac{\hbar}{2}$, and the projection onto **S**, the axis which precesses about the spin axis, is $\hbar$ with a precessing component in the perpendicular plane of $\sqrt{\frac{3}{4}}\hbar$ and a component on the spin axis of $\pm\frac{\hbar}{2}$. Thus, the mystery of an intrinsic angular momentum of $\pm\frac{\hbar}{2}$ and a total angular momentum in a resonant RF experiment of $\mathbf{L}_z = \hbar$ is resolved since the sum of the intrinsic and spin-axis projection of the precessing component is $\hbar$. The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s ($s=\frac{1}{2}$; $m_s=\pm\frac{1}{2}$), and that designation is maintained.

The electron has a measured magnetic field and corresponding magnetic moment of a Bohr magneton and behaves as a spin 1/2 particle or fermion. For any magnetic field, the solution for the corresponding current from Maxwell's equations is unique. Thus, the electron field requires a unique current according to Maxwell's equations. Several boundary conditions must be satisfied, and the orbitsphere equation of

motion for $\ell = 0$ is solved as a boundary value problem. The boundary conditions are:

(1) each infinitesimal point (position) on the orbitsphere comprising a charge- (mass)-density element must have the same angular and linear velocity given by Eqs. (1.55) and (1.56), respectively;

(2) according to condition 1, every such infinitesimal point must move along a great circle and the current-density distribution must be uniform;

(3) the electron magnetic moment must align completely parallel or antiparallel with an applied magnetic field in agreement with the Stern-Gerlach experiment;

(4) according to condition 3, the projection of the intrinsic angular momentum of the orbitsphere onto the z-axis must be $\pm\frac{\hbar}{2}$, and the projection into the transverse plane must be $\pm\frac{\hbar}{4}$ to achieve the spin 1/2 aspect;

(5) the Larmor excitation of the electron in the applied magnetic field must give rise to a component of electron spin angular momentum that precesses about the applied magnetic field such that the contribution along the z-axis is $\pm\frac{\hbar}{2}$ and the projection onto the orthogonal axis which precesses about the z-axis must be $\pm\sqrt{\frac{3}{4}}\hbar$;

(6) due to conditions 4 and 5, the angular momentum components corresponding to the current of the orbitsphere and that due to the Larmor precession must rise to a total angular momentum on the applied-field axis of $\pm\hbar$;

(7) due to condition 6, the precessing electron has a magnetic moment of a Bohr magneton, and

(8) the energy of the transition of the alignment of the magnetic moment with an applied magnetic field must be given by Eqs. (1.194-1.195) wherein the g factor and Bohr magneton factors are due to the extended-nature of the electron such that it links flux in units of the

magnetic flux quantum and has a total angular momentum on the applied-field axis of $\pm\hbar$.

The resulting current is uniform corresponding to Y00 that gives rise to spin angular momentum and is in agreement with all measurements of this phenomenon. The spin energy and angular momentum are calculated classically and are given in Section 88 above. The constant spin function can be modulated with a spherically and time-harmonic charge-density wave. The constant function, the modulation function, and the constant function plus the modulation function are solutions of the two-dimensional wave equation plus time. The corresponding orbital energies are given in Section 88 above.

Section 94

Examiner Souw's further argues on pages 31-32 of his Appendix that:

(c.5) Fifthly, what is correctly meant by McQuarrie with his wavefunction involving **á** and **â** is well known in the art as Pauli wavefunctions represented by 2-dimensional eigenvector with <u>components</u> $ø^+$ and $ø^-$ [3, 7, 8], each of which being an independent function of (***r***,t), i.e., $ø^+$= $ø_{100\_}$ (***r***,t), and $ø^-$= $ø_{100-\_}$(***r***,t), as presented by McQuarrie in Eq.8-51 on pg.301. These two independent and mutually orthogonal eigenfunctions are most conveniently written in the form of column vector components $ø^+$ = **á**$Y_{L,m}$(r,ö)$R_{n,L}$(r) and $ø^-$ = **â**$Y_{L,m}$(r,ö)$R_{n,L}$(r), as recited in Eq.1 of the Examiner's own work [3], as well as in Ref.[7] (Eqs.5.42-47), where **á**=[1,0]=column vector, **â**=[0, 1]=column vector, $Y_{L,m}$(r,ö) is the conventional orbital angular momentum eigenfunction (=spherical harmonics, <u>with L=0 included</u> (see [1] Eq.6-76 on pg.215), and $R_{n,L}$(r) is the conventional radial function (=associated Laguerre function, in case of hydrogen wave function; see [1] Eq.6-102 on pg.223). The two eigenvector components $ø^+$ = **á**$Y_{L,m}R_{n,L}$ and $ø^-$ = **â**$Y_{L,m}R_{n,L}$ are generally known in the art as Pauli eigenvectors (components) [3, 7].

Mathematically they are equivalent to McQuarrie's Eq.8-51, in which McQuarrie's spin functions á(ó) and â(ó) have been specifically

represented by the Pauli spin vectors **á** and **â**, both satisfying the orthogonality condition as given by McQuarrie in Eq.4-46, since **á?â**=0=**â?á**, **á?á**=1=**â?â**, ?dó=1. and both also satisfying McQuarrie's eigenvalue equations 8-43.

It has been thus shown, that McQuarrie Ref. [1] perfectly agrees with the Examiner's refutation as presented in the previous Appendix as well as in Examiner's Ref.[3], whereas Applicant's GUT wavefunction does not comply with his own cited reference [1], while also violating fundamental laws of mathematics and physics. Note: Ref.[7, 8] are new citations, to show that the Pauli wave functions, $ø^+$ and $ø^-$, are well-known and widely used in the art, as equivalents to McQuarrie's. Thus, applicant's refutation of conventional QM stems from his own misunderstanding of the subject matter, including his own cited reference [1].

The Examiner has captured the argument of SQM with its rules and representations of spin in zero dimensions, but the results are not predictive and are not in agreement with observations, as noted previously. Applicant's objective was to physically solve for real current functions that match the data (not the nonsense of current in zero-dimensional space). Applicant's solutions are predictive and match the observations. That they are different from the old formalisms (such as the Pauli spin vectors **á** and **â**, both satisfying the orthogonality condition) is expected since the old approach is NOT CORRECT.

Section 95

Examiner on Souw further argues on Appendix page 32:

This is not an *a priori* standpoint taken by the Examiner, as alleged by Applicant, but has been conclusively drawn from the unprecedented amount of self-contradictory and erroneous arguments of record presented by Applicant that show Applicant's complete misunderstanding of the QM.

Applicant understands SQM very well to the point that he appreciates and admits that it can not possibly be correct. Even the founders of quantum mechanics argued this as pointed out in Applicant's papers:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

Applicant was fortunate in that he had a quantum mechanics professor who was honest and taught that "SQM should be used as a tool, it is the best we can do at the moment, but it has many problems including the fact that it is not based on physical laws learned in prior courses and is not easily interpreted in terms of physical reality." Little did he know at the time that one of his students would take an initiative to his prediction that "some day someone will replace it with the correct theory of atomic physics."

Section 96

Examiner Souw continues on page 32 of his Appendix, erroneously arguing:

The Examiner also continues to disagree with applicant's repeated recitation (and "refutation"!) of Dirac's formulation of particle with spin _ in the form of a 4-vector (see e.g., [9] & Drell) , which is known in the art as being a natural (i.e., relativistic) extension of the 2-dimensional Pauli vector wave functions to 4-dimensional Dirac vectors that automatically represents anti-particles. Given that applicant has misunderstood Dirac's relativistic formulation, applicant's argument regarding this issue is unpersuasive.

The Dirac equation is wrong, as pointed out above and in the paper

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted:

II. Quantum Electrodynamics (QED)

Quantum mechanics failed to predict the results of the Stern-Gerlach experiment which indicated the need for an additional quantum number. In quantum mechanics, the spin angular momentum of the electron is called the "intrinsic angular momentum" since no physical interpretation exists. (Currents corresponding to the observed magnetic field of the electron can not exist in one dimension of four dimensional spacetime where Ampere's law and the intrinsic special relativity determine the corresponding unique current.) The Schrödinger equation is not Lorentzian invariant in violation of special relativity. The Schrödinger equation also misses the Lamb shift, the fine structure, and the hyperfine structure completely, and it is not stable to radiation. Quantum electrodynamics was proposed by Dirac in 1926 to provide a generalization of quantum mechanics for high energies in conformity with the theory of special relativity and to provide a consistent treatment of the interaction of matter with radiation. But, it does not bridge the gap between quantum mechanics and special relativity. From Weisskopf [19], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; (1) does not explain nonradiation of bound electrons; (2) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; (3) it admits solutions of negative rest mass and negative kinetic energy; (4) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; (5) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise. Dirac's postulated relativistic wave equation gives the inescapable result of a cosmological constant that is at least 120 orders of magnitude larger than the best observational limit due to the unacceptable states of negative mass for the description of the vacuum as

discussed previously [2-7, 9-10][26]. The negative mass states further create an absolute "ether"-like frame in violation of special relativity which was disproved by the Michelson-Morley experiment.

In retrospect, Dirac's equation which was postulated to explain spin relies on the unfounded notions of negative energy states of the vacuum, virtual particles, and gamma factors; thus, it can not be the correct description of a bound electron even though it gives an addition quantum number interpreted as corresponding to the phenomenon of electron spin. Ironically, it is not even internally consistent with respect to its intent of being in accord with special relativity. In addition to violating Maxwell's equation with respect to stability to radiation wherein Maxwell's equations are implicit and the internal inconsistency with special relativity regarding the classical electron radius and states of negative rest mass and negative kinetic energy as given by Weisskopf [19], the Dirac equation violates Einstein causality and locality and conservation of energy as shown by the Klein Paradox discussed previously [2, 4, 7][27]. Furthermore, everyday observation demonstrates that causality and locality always hold. Einstein also argued that a probabilistic versus deterministic nature of atomic particles leads to disagreement with special relativity. In fact, the nonlocality result of the Copenhagen interpretation violates causality as shown by Einstein, Podolsky, and Rosen (EPR) in a classic paper [22] that presented a paradox involving instantaneous (faster-than-light) communication between particles called "spooky action at a distance" which led them to conclude that quantum mechanics is not a complete or correct theory. The implications of the EPR paper and the exact Maxwellian predictions of "spooky action" and "entanglement" experiments,

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[26] The Rutherford experiment demonstrated that even atoms are comprised of essentially empty space [20]. Zero-point field fluctuations, virtual particles, and states of negative energy and mass invoked to describe the vacuum are nonsensical and have no basis in reality since they have never been observed experimentally and would correspond to an essentially infinite cosmological constant throughout the entire universe including regions of no mass. As given by Waldrop [21], "What makes this problem into something more than metaphysics is that the cosmological constant is observationally zero to a very high degree of accuracy. And yet, ordinary quantum field theory predicts that it ought to be enormous, about 120 orders of magnitude larger than the best observational limit. Moreover, this prediction is almost inescapable because it is a straightforward application of the uncertainty principle, which in this case states that every quantum field contains a certain, irreducible amount of energy even in empty space. Electrons, photons, quarks—the quantum field of every particle contributes. And that energy is exactly equivalent to the kind of pressure described by the cosmological constant. The cosmological constant has accordingly been an embarrassment and a frustration to every physicist who has ever grappled with it."

[27] Oskar Klein pointed out a glaring paradox implied by the Dirac equation which was never resolved [23]. "Electrons may penetrate an electrostatic barrier even when their kinetic energy, $E - mc^2$ is lower than the barrier. Since in Klein's example the barrier was infinitely broad this could not be associated with wave mechanical tunnel effect. It is truly a paradox: Electrons too slow to surpass the potential, may still only be partially reflected. ...Even for an infinitely high barrier, i.e. $r_2 = 1$ and energies $\approx 1\,MeV$, (the reflection coefficient) R is less than 75%! From (2) and (3) it appears that as soon as the barrier is sufficiently high: $V > 2mc^2$, electrons may transgress the repulsive wall—seemingly defying conservation of energy. ...Nor is it possible by way of the positive energy spectrum of the free electron to achieve complete Einstein causality."

incorrectly interpreted in the context of quantum mechanic, are given in Chp. 37 of Ref. [7].

In 1947, contrary to Dirac's predictions, Lamb discovered a $1000\ MHz$ shift between the $^2S_{1/2}$ state and the $^2P_{1/2}$ state of the hydrogen atom [24]. This so called Lamb Shift marked the beginning of modern quantum electrodynamics. In the words of Dirac [25], "No progress was made for 20 years. Then a development came initiated by Lamb's discovery and explanation of the Lamb Shift, which fundamentally changed the character of theoretical physics. It involved setting up rules for discarding ...infinities..." Renormalization is presently believed to be required of any fundamental theory of physics [26]. However, dissatisfaction with renormalization has been expressed at various times by many physicists including Dirac [27] who felt that, "This is just not sensible mathematics. Sensible mathematics involves neglecting a quantity when it turns out to be small—not neglecting it just because it is infinitely great and you do not want it!"

Albeit, the Dirac equation did not predict the Lamb shift or the electron g factor [24, 28-29], its feature of negative-mass states of the vacuum gave rise to the postulates of QED that has become a center piece of quantum mechanics to explain these and other similar observations. One of QED's seminal aspects of renormalization which was subsequently grafted into atomic theory was a turning point in physics similar to the decision to treat the electron as a point-particle-probability wave, a point with no volume with a vague probability wave requiring that the electron have an infinite number of positions and energies including negative and infinite energies simultaneously. The adoption of the probabilistic versus deterministic nature of atomic particles violates all physical laws including special relativity with violation of causality as pointed out by Einstein [22] and de Broglie [30]. Consequently, it was rejected even by Schrödinger [31].

Pure mathematics took the place of physics when calculating subtle shifts of the hydrogen atomic energy levels. Moreover, in QED, the pure mathematics approach has been confused with physics to the point that virtual particles are really considered as causing the observable. The justification for the linkage is often incorrectly associated with the usage of series expansion and variational methods to solve problems based on physical laws. But, series expansion of an equation based on a physical action or variation of a physical parameter of the equation versus the fabrication of an action based on fantastical untestable constructs that are represented by a series are clearly different. For example, the motion of a pendulum can be solved exactly in terms of an elliptic integral using Newtonian mechanics. Expansion of the elliptic integral in a power series and ignoring negligible terms in the series versus setting up of arbitrary rules for *discarding infinities* are clearly not the same. Furthermore, inventing virtual particles that have an action on space, and subsequently on an electron, versus expanding terms in the energy equation due to a gravitating body causing a gravitational field and thus an

action on the pendulum are very different. In QED, virtual particles are not merely a sustitutional or expansion variable. They are really considered as causing the observable.

In a further exercise of poor science, virtual-particle-based calculations are even included in the determination of the fundamental constants which are circularly used to calculate the parameter ascribed to the virtual particles. For example, using the electron magnetic moment anomaly in the selection of the best value of the fine structure constant, the CODATA publication [32] reports the use of virtual particles:

> "The term A1 is mass independent and the other terms are functions of the indicted mass ratios. For these terms the lepton in the numerator of the mass ratio is the particle under consideration, while the lepton in the denominator of the ratio is the virtual particle that is the source of vacuum polarization that gives rise to the term."

There is no direct evidence that virtual particles exist or that they polarize the vacuum. Even their postulation is an oxymoron.

Throughout the history of quantum theory, wherever there was an advance to a new application, it was necessary to repeat a trial-and -error experimentation to find which method of calculation gave the right answers. Often the textbooks present only the successful procedure as if it followed from first principles and do not mention the actual method by which it was found. In electromagnetic theory based on Maxwell's equations, one deduces the computational algorithm from the general principles. In quantum theory, the logic is just the opposite. One chooses the principle (e.g. phenomenological Hamiltonians) to fit the empirically successful algorithm. For example, we know that it required a great deal of art and tact over decades of effort to get correct predictions out of QED. The QED method of the determination of $(g-2)/2$ from the *postulated* Dirac equation is based on a *postulated* power series of α/π where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term which is processed over decades using ad hoc rules to remove infinities from each term that arises from *postulated* scores of *postulated* Feynman diagrams. The solution so obtained using the perturbation series further requires a *postulated* truncation since the series *diverges*. Mohr and Taylor reference some of the Herculean efforts to arrive at g using QED [32]:

> "the sixth-order coefficient $A_1^{(6)}$ arises from 72 diagrams and is also known analytically after nearly 30 years of effort by many researchers [see Roskies, Remiddi, and Levine (1990) for a review of the early work]. It was not until 1996 that the last remaining distinct diagrams were calculated analytically, thereby completing the theoretical expression for $A_1^{(6)}$".

For the right experimental numbers to emerge, one must do the calculation (i.e. subtract off the infinities) in one particular way and not in some other way that appears in principle equally valid. For example, Milonni [33] presents a

QED derivation of the magnetic moment of the electron which gives a result of the wrong sign and requires the introduction of an

> "upper limit K in the integration over $k = \omega / c$ in order to avoid a divergence."

A differential mass is arbitrarily added, then

> "the choice $K = 0.42mc/\hbar$ yields $(g-2)/2 = \alpha / 2\pi$ which is the relativistic QED result to first order in α. [...] However, the reader is warned not to take these calculations too seriously, for the result $(g-2)/2 = \alpha / 2\pi$ could be obtained by retaining only the first (radiation reaction) term in (3.112) and choosing $K = 3mc/8\hbar$. It should also be noted that the solution $K \cong 0.42mc/\hbar$ of (3.112) with $(g-2)/2 = \alpha / 2\pi$ is not unique."

Such an ad hoc nonphysical approach makes incredulous:

> " the cliché that QED is the best theory we have!" [34]

or the statement that:

> "The history of quantum electrodynamics (QED) has been one of unblemished triumph" [35].

There is a corollary, noted by Kallen: from an inconsistent theory, any result may be derived.

In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified after Schrödinger, a classical approach was explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level [2-7]. Physical laws and intuition are restored when dealing with the wave equation and quantum mechanical problems. Specifically, a theory of classical quantum mechanics (CQM) was derived from first principles that successfully applies physical laws on all scales. Rather than use the postulated Schrödinger boundary condition: "$\Psi \to 0$ as $r \to \infty$", which leads to a purely mathematical model of the electron, the constraint is based on experimental observation. Using Maxwell's equations, *the classical wave equation is solved with the constraint that the bound $n = 1$-state electron cannot radiate energy*. The electron must be extended rather than a point. On this basis with the assumption that physical laws including Maxwell's equation apply to bound electrons, the hydrogen atom was solved exactly from first principles. The remarkable agreement across the spectrum of experimental results indicates that this is the correct model of the hydrogen atom.

It was shown previously that quantum mechanics does not explain the stability of the atom to radiation [2]; whereas, the Maxwellian approach gives a natural relationship between Maxwell's equations, special relativity, and general relativity. CQM holds over a scale of spacetime of 85 orders of magnitude—it correctly predicts the nature of the universe from the scale of the quarks to that of the cosmos [3]. A review is given by Landvogt [36]. In a third paper, the atomic physical approach was applied to multielectron atoms that

were solved exactly disproving the deep-seated view that such exact solutions can not exist according to quantum mechanics. The general solutions for one through twenty-electron atoms are given in Ref [4]. The predictions are in remarkable agreement with the experimental values known for 400 atoms and ions. A fourth paper presents a solution based on physical laws and fully compliant with Maxwell's equations that solves the 26 parameters of molecular ions and molecules of hydrogen isotopes in closed-form equations with fundamental constants only that match the experimental values [5]. In a fifth paper, the nature of atomic physics being correctly represented by quantum mechanics versus classical quantum mechanics is subjected to a test of internal consistency for the ability to calculate the conjugate observables using the same solution for each of the separate experimental measurements [6]. It is confirmed that the CQM solution is the accurate model of the helium atom by the agreement of predicted and observed conjugate parameters of the free electron, ionization energy of helium and all two electron atoms, ionization energies of multielectron atoms, electron scattering of helium for all angles, and all He I excited states using the same unique physical model in all cases. Over five hundred conjugate parameters are calculated using a unique solution of the two-electron atom without any adjustable parameters to achieve overall agreement to the level obtainable considering the error in the measurements and the fundamental constants in the closed-form equations.

In contrast, the quantum fails utterly. Ad hoc computer algorithms are used to generate meaningless numbers with internally inconsistent and nonphysical models that have no relationship to physics. Attempts are often made to numerically reproduce prior theoretical numbers using adjustable parameters including arbitrary wave functions in computer programs with precision that is often much greater (e.g. 8 significant figures greater) than possible based on the propagation of errors in the measured fundamental constants implicit in the physical problem.

In this sixth paper of a series, rather than invoking renormalization, untestable virtual particles, and polarization of the vacuum by the virtual particles, the results of QED such as the anomalous magnetic moment of the electron, the Lamb Shift, the fine structure and hyperfine structure of the hydrogen atom, and the hyperfine structure intervals of positronium and muonium (thought to be only solvable using QED) are solved exactly from Maxwell's equations to the limit possible based on experimental measurements.

Section 97

Examiner Souw's inconsistent positions are further exposed on pages 32-33 of his Appendix, wherein he states:

(d) On pg.65, Applicant's argument regarding dphi>inifnity dphi>2pi only reflects Applicant's misunderstanding regarding multi-valued functions. Furthermore, Applicant's wording *"in order not to violate the HUP"* does not make sense to those of ordinary skill in the art, since a constant probability density in all space having dx=inifnity does not violate the HUP at all, but is the manifestation of HUP (both äp=0?äx=? and äx=0?äp=? strictly obey the HUP, äp?äx??). The same conceptual error has been previously discussed in sub-paragraph 6(b). Such a serious misunderstanding of the HUP ultimately disqualifies Applicant's arguments altogether.

With regard to the Examiner's statement that "a constant probability density in all space having dx=inifnity does not violate the HUP at all," it is amazing that he can believe that the single electron is over all space simultaneously and instantaneously and still maintain that physical laws are not violated. The Examiner's inability to even recognize this conundrum, much less resolve it, is symptomatic of the problems with his flawed analysis.

Furthermore, with regard to the case presented in Applicant's paper 80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted, the following relevant passage provides:

For the n=1 state, $\ell = 0$; thus, **the angular momentum according to the Schrodinger equation is exactly zero—not $\hbar$.** Furthermore, the kinetic energy of rotation K_{rot} is also **zero**. As a consequence, it is internally inconsistent for Feynman to accept the HUP which arises from the Schrodinger equation on the one hand and that the electron obeys the classical Coulomb law and is bound in an inverse squared Coulomb field on the other. Rather than a kinetic energy of $\frac{\hbar^2}{2mr^2}$ which is added to the Coulomb energy of $-\frac{e^2}{r}$ to get the total energy, exactly zero should be added to the Coulomb energy. This is an inescapable nonsensical result which arises from the SE directly, and it can not be saved by incorrectly assigning the angular momentum as $\hbar$ from the uncertainty relationship. Furthermore, the result that L = K_{rot} **= exactly zero violates the HUP making the argument further internally inconsistent.** In addition,

applying Eq. (3) to spherical harmonic solutions for Ψ with an exact momentum and energy for a given ℓ in Eqs. (11) and (12), respectively, requires that $\Delta\theta \to \infty$ since $\Delta L = 0$ in the relationship $\Delta L \Delta\theta \geq \frac{\hbar}{2}$. The result $\Delta\theta \to \infty$ is nonsensical. Postulating a linear combination of spherical harmonics is not consistent with a single momentum state and will not save the HUP since the linear combination is not an eigenfunction. Rather it is a wavefunction of a set that is not orthonormal (i.e. it violates QM postulates by not yielding the Kroenecker delta).

The HUP is violated. Using the Examiner's insistence that "dphi>inifnity dphi>2pi only reflects Applicant's misunderstanding regarding multi-valued functions", the insertion of 2pi in the HUP gives

$$\begin{aligned} \sigma_x \sigma_p &\geq \frac{\hbar}{2} \\ 2\pi 0 &\geq \frac{\hbar}{2} \\ 0 &\geq \frac{\hbar}{2} \end{aligned} \tag{6}$$

which is a violation as pointed out by Applicant in the previous Response.

Section 98

Examiner Souw further argues on Appendix page 33 that:

7. Applicant's misunderstanding of the Uncertainty Principle in QM

(a) Unlike the uncertainty of position and linear momentum, there is no äö>? in case of sharply defined angular momentum (äL>0), but only äö>2∂ since äö>? inevitably ends up in being confined within 2∂ due to the multiple values of the angular variable ö. Applicant's confusion in such a simple problem is another evidence for Applicant's misunderstanding of the HUP.

Applicant is confident that there is no understanding SQM, as noted by Feynman, Dirac, and other quantum theoreticians. Furthermore, the Examiner's requirement that L=0 phi=2phi violates the HUP and shows that he has trouble with

simple arithmetic, let alone understanding a theory that has defied interpretation for 80 years. See:

F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701.

Section 99

Examiner Souw further errs in his statements on Appendix page 33 that:

> (b) Applicant's has failed to remove, or even properly address the Examiner's points of refutation in the previous Appendix. Consequently, said refutation remains in force, and is here re-instated by incorporation, in addition to new proofs of errors and misunderstanding encompassed in Applicant's response(s), to be detailed as follows.

Applicant notes that the problems that the Examiner is having with understanding Applicant's theory is that (1) he is mistaken in his claim that SQM uses physical laws; the mathematics of SQM violates physical laws; and (2) he tries to interpret Applicant's physical approach from the perspective of SQM with the false presumption that this approach in right, even given that SQM is alien to physical laws.

Section 100

Examiner Souw further asserts on Appendix page 33:

> (c) There is no such thing as *"mathematics versus physics"* as alleged by Applicant; but rather, the two aspects always develop hand-in-hand (see section 5a(a) above). As known in the art, besides experimental evidence, physics is built on rigorous mathematics.

The Examiner's point does not resolve anything. There is certainly a distinction between pure mathematics and physics. There is an infinite body of mathematics that has no connection to real world physics. Mathematics is merely a tool to model physics. SQM is pure mathematics and curve-fitting. It is not predictive and has no physical meaning. SQM only produces numbers that are forced to match experimental numbers when the adjustable parameters are varied accordingly.

Section 101

Examiner Souw further states on pages 33-34 of his Appendix that:

> (d) Applicant's argument regarding the Examiner's "bias by QM" is inappropriate because it is the Examiner's job to understand the scientific principles behind an invention by using tools made available to him by conventionally accepted science. QM is one of those tools that has been conventionally and objectively accepted by the scientific community. The Examiner plays no role in the scientific community's acceptance of QM.

Applicant is entitled to fair, competent, and unbiased evaluation of his application under the U.S. patent laws. Even if it is not willful intent, the Examiner's lifelong education in the field of SQM has incapacitated him from evaluating Applicant's invention, which is based on physical laws. The mastering of SQM requires a certain "suspension of belief' in physics. The Examiner's biased and corrupted myopic view is evident as pointed out in Section 99 above. Applicant believes a fair evaluation of his novel hydrogen technologyl requires the replacement of the Examiner of Record with one educated in physical laws. Perhaps, an engineer rather than a SQM theoretician, since Applicant's theory based on physical laws teaches against the nonphysical SQM.

Section 102

Examiner Souw further argues on Appendix page 34 that:

> In each and every instance as evidenced by applicant's response throughout the entire prosecution history of this application, the applicant uses the competitor argument whenever his theory is refuted by any individual who provides sound mathematical and physical arguments based on conventionally accepted science such as QM to disprove applicant's mathematically and physically flawed theory. However, it is must be emphasized that QM is not a competing theory but a conventionally accepted theory. Applicant has not provided any solid evidence that QM is flawed. All of applicant's previous arguments regarding the deficiencies of QM and attempts to disprove QM have been refuted by the Examiner in the previous and current arguments of record.

Applicant has presented many examples where SQM is flawed, as have many other noted theoreticians, including the most prominent founders of SQM as pointed out in the following papers.

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physics Essays, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Annales de la Fondation Louis de Broglie, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2005 Edition posted at www.blacklightpower.com.

The Examiner just chooses to ignore them.

That others use what is available even though SQM is not right does not preclude the possibility that the correct theory can or will not be found. Furthermore, the results of CQM are unmatched by any version of SQM over its entire history. CQM gives closed-formed equations containing fundamental constants for 100's of predictions that match the experimental values with remarkable agreement, as discussed in Sections 54-55 and 69-70 above. Not a single, predictive internally

consistent equation based on physics has ever been given by SQM, as discussed in the papers cited above.

Section 103

On page 34 of the Souw Appendix, the Examiner further asserts that:

> Regarding Applicant's request to have his applications examined by an Examiner who is "skilled in Maxwell equations", the MPEP states that a rejection may rely upon facts within the examiner's own/personal knowledge or other PTO employee(s); see MPEP 2 144.03(C), 37 CFR 1.1 04(c)(3) and 37 CFR 1.1 04(dX2). In this regard, the Examiner's skill in the pertinent art, both theoretical and experimental, is documented in his publication [10]. Note, the cited work has been accomplished by the Examiner 17 years ago, such that a "conflict of interest" argument is without merit.

First, it is obvious that the Examiner has not studied Applicant's "conflict of interest argument,' as his comments are non responsive. Further, it is clear that the Examiner does not have the right background when he argues that he is applying physical laws on the one hand, and then uses the HUP on the other.

The Uncertainty Principle [23. D. A. McQuarrie, *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), pp. 135-140] is

$$\sigma_x \sigma_p \geq \frac{\hbar}{2} \tag{6}$$

where σ_x and σ_p are given by

$$\sigma_x^2 = \int \psi^* \left(\hat{X} - \langle x \rangle\right)^2 \psi dx \tag{7}$$

$$\sigma_p^2 = \int \psi^* \left(\hat{P} - \langle p \rangle\right)^2 \psi dx \tag{8}$$

The definition of the momentum operator in a *one dimensional* system is [23]

$$\hat{P}_x = -i\hbar \frac{d}{dx} \tag{9}$$

and the position operator is

$$\hat{X} = x \qquad (\text{multiply by x}) \tag{10}$$

The Uncertainty Principle is also expressed as

$$\Delta x \Delta p \geq \frac{\hbar}{2} \quad (3)$$

It is not founded on an argument about the measurement of conjugate parameters; rather it is based on the premise that reality is not definite or has no state until it is measured and the measurement device becomes entangled with the object being measured and is inseparable from it.

The Examiner states that SQM is based on physical laws. This is absolutely not true. The Examiner simply must face the reality of his belief in the Heisenberg Uncertainty Principle, requiring that all atomic objects have no physical form, that spooky action is implicit in all atomic interactions (faster than light action at a distance is predicted for all events), that atomic objects are everywhere at once (infinite number of positions and energies simultaneously, including ones of positive or negative infinity at the same instant in time), that contradictory statement must be taken as true simultaneously, that there is no causality, that time is quantized rather than continuous, even though it is disproved by the Hubble images, that every point in space contains an infinity of virtual particles that pop into and out of existence constantly, but are never observed and require a cosmological constant 120 orders of magnitude higher than the highest possible value observed, and that there are many more consequences such as infinities, Klein paradox, other paradoxes, etc. that arise.

The Examiner insists that SQM is based on physical laws. Physical laws are exact experimentally confirmed relationships. The Heisenberg Uncertainty Principle does not permit exact relationships. Thus, the following laws that are exact relationships without any uncertainty violate the Heisenberg Uncertainty Principle:

- Conservation of linear and angular momentum
- Conservation of energy
- The relativistic invariance of charge

Planck's equation

$$E = \hbar\omega = h\frac{\omega}{2\pi} = h\nu = hf = h\frac{c}{\lambda} \tag{2.75}$$

$\mathbf{p}$, the momentum of the photon

$$\mathbf{p} = mc = \frac{E_{h\nu}}{c} \tag{2.77}$$

where c is the velocity of light, so that

$$M\mathbf{V} = M(\mathbf{V} + \mathbf{v}) + \frac{E_{h\nu}}{c} \tag{2.78}$$

And, the recoil momentum is

$$M\mathbf{v} = -\frac{E_{h\nu}}{c} \tag{2.79}$$

Thus, the recoil energy is given by

$$E_R = \frac{E_{h\nu}^2}{2Mc^2} \tag{2.80}$$

The Schwarzschild metric

$$d\tau^2 = \left(1 - \frac{2Gm_0}{c^2 r}\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{2Gm_0}{c^2 r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \tag{24.2}$$

Newton's Law of Gravitation for $\frac{r_g}{r_\alpha^*} << 1$

$$\mathbf{F} = \frac{Gm_1m_2}{r^2} \tag{24.3}$$

where G is the Newtonian gravitational constant.

Maxwell's Equations

$$\nabla \times \mathbf{E} = -\frac{\partial \mu_o \mathbf{H}}{\partial t} \tag{24.4}$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \varepsilon_o \mathbf{E}}{\partial t} \tag{24.5}$$

$$\nabla \bullet \varepsilon_o \mathbf{E} = \rho \tag{24.6}$$

$$\nabla \bullet \mu_o \mathbf{H} = 0 \tag{24.7}$$

Maxwell's Integral Laws in Free Space:

Ampere's Law

$$\oint_C \mathbf{H} \bullet d\mathbf{s} = \int_S \mathbf{J} \bullet d\mathbf{a} + \frac{d}{dt}\int_S \varepsilon_0 \mathbf{E} \bullet d\mathbf{a} \qquad (24.8)$$

Faraday's Law

$$\oint_C \mathbf{E} \bullet d\mathbf{s} = -\frac{d}{dt}\int_S \mu_0 \mathbf{H} \bullet d\mathbf{a} \qquad (24.9)$$

The Poynting power theorem:

$$\nabla \bullet (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t}\left[\frac{1}{2}\mu_o \mathbf{H} \bullet \mathbf{H}\right] - \frac{\partial}{\partial t}\left[\frac{1}{2}\varepsilon_o \mathbf{E} \bullet \mathbf{E}\right] - \mathbf{J} \bullet \mathbf{E} \qquad (24.10)$$

Newtonian mechanics for $v << c$:

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} = \frac{d(m\mathbf{v})}{dt} = m\frac{d\mathbf{v}}{dt} = m\mathbf{a} \qquad (24.11)$$

$$T = \frac{1}{2}mv^2 \qquad (24.12)$$

Special Relativity that applies when v approaches c:

$$E = mc^2 \qquad (24.13)$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (24.14)$$

$$l = l_o\sqrt{1 - \frac{v^2}{c^2}} \qquad (24.15)$$

$$t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (24.16)$$

where the subscript denotes the value in the rest frame.

The relationship between the speed of light, c, and the permittivity of free space, ε_0, and the permeability of free space, μ_0

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \tag{24.28}$$

The fine structure constant relationship

$$\alpha = \frac{1}{4\pi}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{e^2}{\hbar} = \frac{1}{2}\frac{\sqrt{\frac{\mu_0}{\varepsilon_0}}}{\frac{h}{e^2}} = \frac{\mu_0 e^2 c}{2h} \tag{24.29}$$

The relationship for the radiation resistance of free space, η.

$$\eta = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 4\pi\alpha\frac{\hbar}{e^2} \tag{24.30}$$

The provision of a limiting speed of c for the propagation of any wave, including gravitational and electromagnetic waves and expanding spacetime.

The transition lifetime, τ, of the electric multipole moment given by

$$Q_{lm} = \frac{3}{\ell + 3} e (r_n)^\ell \tag{24.34}$$

of [1]

$$\tau = \frac{energy}{power}$$

$$\tau = \frac{[\hbar\omega]}{\left[\frac{2\pi c}{[(2l+1)!!]^2}\left(\frac{l+1}{l}\right)k^{2l+1}\left|Q_{lm} + Q'_{lm}\right|^2\right]} = \frac{1}{2\pi}\left(\frac{h}{e^2}\right)\sqrt{\frac{\varepsilon_0}{\mu_0}}\frac{[(2l+1)!!]^2}{2\pi}\left(\frac{l}{l+1}\right)\left(\frac{l+3}{3}\right)^2\frac{1}{(kr_n)^{2l}\omega} \tag{24.35}$$

Furthermore, in addition to failing to provide for the stability of the hydrogen atom, the Heisenberg Uncertainty Principle has been directly disproved by many observations such as those of the Hubble space telescope, interferometry experiments,

and the nonexistence of an infinite cosmological constant as detailed in Applicant's paper

80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted.

as well as the following papers:

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction", Physica Scripta, submitted.
106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium Which Predicts Conjugate Parameters from a Unique Solution for the First Time", Progress of Physics, submitted.
102. R. L. Mills, "Exact Classical Quantum Mechanical Solutions for One- Through Twenty-Electron Atoms", Physics Essays, submitted.
94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", Physics Essays, in press.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, in press.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, The Grand Unified Theory of Classical Quantum Mechanics, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2004 Edition posted at www.blacklightpower.com.

Section 104

Examiner Souw errs once again in arguing on pages 34-35 of this Appendix that:

(e) Applicant's reference to Ref.[80] for alleged "failures" of HUP is unpersuasive, since Ref [80] is written by Applicant himself, and has been deemed incredible for being full of mathematical flaws and incorrect

> interpretations of physics principles, as previously discussed. Applicant's misinterpretation of HUP is obviously also the source for his incorrect understanding of a number of references presented on pg.65 of his Response. Beyond his blind citation of the references, Applicant has failed to identify what he meant with "inconsistency" and "paradox".

This is NOT TRUE. As shown in Sections 66-67 above, other theoreticians such as those at Princeton University agree with Applicant's arguments given in ref. # 80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Annales de la Fondation Louis de Broglie, submitted] that the Heisenberg Uncertainty Principle provides no atomic stability [E. H. Lieb, "The stability of matter", Reviews of Modern Physics, Vol. 48, No. 4, (1976), pp, 553-569.

Lieb [34] also addresses the fact that the Schrödinger equation has been accepted for over a half of a century without addressing the stability of matter. Lieb also shows that the Feynman argument is "false" due to an inappropriate application of the Heisenberg Uncertainty Principle and admonishes the misrepresentation in textbooks. By considering a wavefunction comprised of two components at two radii such that the electron can not have both sharply defined momentum and position in accordance with the Uncertainty Principle, Lieb shows that the radius can be arbitrarily small including zero such that the energy is negative infinity. This result is obviously not predictive of stability.

Furthermore, the approach by Feynman and Lieb are physically baseless. Attempts to prove that a system has a kinetic energy that exceeds some lower bound such that the total energy is not negative infinity is not based on physics since it ignores radiation-loss terms. More recently, Bugliaro at al. [35] have attempted to use QED to prove the stability of matter with N nonrelativistic electrons and K static nuclei of nuclear charge $\leq Ze$ that can interact with photons. Here, the problem is "rigged" since the radiation field is defined to be quantized, an ultraviolet cutoff is arbitrarily imposed, Maxwell's equations are not obeyed due to the defined properties of the polarizations, and creation and annihilation operators including the limitation of the couplings of

photons to electrons via Pauli operators only. Furthermore, the proof has nothing to do with the solutions of the actual atomic energy levels. Even then, stability is only found for a nuclear charge $Z \leq 6$. Thus, it is evident that neither the Schrödinger equation, variants thereof, or QED provide a general, self consistent, rigorous, and physical basis for the stability of matter.

34. E. H. Lieb, "The stability of matter", Reviews of Modern Physics, Vol. 48, No. 4, (1976), pp, 553-569.
35. L. Bugliaro, J. Fröhlich, G. M. Graf, "Stability of quantum electrodynamics with nonrelativistic matter", Physical Review Letters, Vol. 77, No. 17, (1996), pp. 3494-3497.

Furthermore, as demonstrated in Section 103 above, the implications of the HUP are not understood by the Examiner who creates a paradox between his insistence that physical laws and the HUP are both valid simultaneously.

Section 105

Examiner Souw further argues on Appendix page 35 that:

> "Inconsistency" or "paradox" exists in QM only in philosophical terms, depending on the philosophical standpoint of the individual author who made the statement, primarily with regard to what he/she defines as "reality" (cf. Laloë [5]). For example, the current Copenhagen interpretation of QM --more specifically regarding Schrödinger cat paradox, single particle interference, quantum entanglement, quantum teleportation etc.-- is neither a paradox nor inconsistency, when viewed from the philosophical standpoint of Logical Positivism [11-14] *(*= a modern version of Hume's classical positivism developed by the Vienna Circle --Bohr, Heisenberg, etc—, and is to date tacitly adopted by most physicists and scientists). Under this philosophical viewpoint, "reality" is defined solely as what is perceived by our five senses, as represented by experimental measurements (see, e.g., K. Nakhmanson, [11]).

In SQM, there is no reality in the absence of measurement, only math. Reality is only introduced by act of measurement, but then the measurement device is entangled with the object being measured. Then the meaning of reality is debated. Under CQM, mass, charge, electric and magnetic fields, energy, etc. are real and modeled by math.

They are not math, nor do they obey math; rather they obey physics that is modeled by math. Thus, there is no need for philosophy and metaphysics.

Section 106

Examiner Souw's erroneous analysis is further exposed by his arguments on Appendix pages 35-36:

> Thus, it would be nonsense to talk about non-measurable parameters, such as suggested in the EPR paradox by some "hidden variables" and summarized in the well-known Bell's inequalities in consequence of the classical interpretation of "reality" as local realism. As of late, the Bell's theorem has been experimentally disproved in favor of the so-called Copenhagen interpretation of QM as a non-local theory [11, 15]. The Copenhagen interpretation of QM is also compatible with Pragmatism [16], which declares any knowledge on "reality", including scientific theories, as being "correct" only insofar as it is beneficial to human experience (i.e., not only capable of explaining, but also able to predict and control), the latter again referring to the five senses, or, in short, experimental measurements. The Copenhagen interpretation of QM is even compatible with Kant's metaphysics [15, 17] (foundation of modern philosophy, developed in the 18th century after Newton), which is heavily based on human reasoning (logic, mathematics) and proves that metaphysical "reality" beyond human five-sense perception is not accessible to human knowledge and/or intelligence, as described by his famous argument of "das Ding an sich", or the thing in itself.

The EPR paradox proposed by Einstein reveals that SQM is nonlocal and noncausal (predicts "spooky action" at a distance) in violation of special relativity. This is another contradiction to the Examiner's statement that he is applying physical laws, for which he has no response.

The Examiner's statement that "Bell's theorem has been experimentally disproved in favor of the so-called Copenhagen interpretation of QM as a non-local theory [11, 15]" is specifically noted. Using CQM, with conservation of the angular momentum of the excited-state calcium atom and the emitted photons, Applicant predicts exactly in closed-form equations the results of the Aspect experiment, thus restoring locality and causality and eliminating any need for the nonsensical

philosophical, metaphysical flights of fantasy or other loosening of associations, delusions of grandeur, etc. associated with SQM. See Chp 37 of Mills GUT (Ref. #1).

Section 107

Examiner Souw continues with philosophical arguments, which are found on Appendix page 36:

> In contrast, Applicant's GUT is essentially incompatible with any of those major philosophical views, since the existence of hydrino is not based on experimental evidence (= five-sense perception), and furthermore, the hydrino can not be justified by reason, for obvious violation of logic/mathematics and known laws of nature. However, it is to be emphasized, philosophy is neither a subject matter of physics nor patent examination (non-statutory subject matter). The purpose of the above discussion is just to show that Applicant has misunderstood his own cited references regarding the alleged inconsistencies and paradoxes in QM given on pg.65.

Classical physical laws, however, require no philosophy. They are directly measurably and self evident. Applicant's GUT is predictive of 100's of experimental results. The prediction of hydrino is derived from the same physical laws. It has now been observed experimentally as predicted. It is another failure of SQM that it does not predict hydrino, but this result is expected since it is not predictive of a single experimental conjugate observable and over 80 years has degraded into a philosophical, metaphysical debate.

Section 108

Examiner Souw's philosophical struggle continues on page 36 of his Appendix, wherein he argues:

> It is to be emphasized, philosophy is totally irrelevant to science & technology, since it has no impact whatsoever on the "reality" itself. It does not matter whether Applicant considers single photon interference a paradox or not; a single photon that is split into different arms of an interferometer will still generate measurable interference effects. Similarly, an experiment designed to test the Bell theorem will invariably show the

> theorem is wrong (i.e., there is no hidden variable), no matter whether Applicant rejects a non-local QM theory as paradox, or accept QM as it is. This irrelevancy of philosophical interpretation is commonly shared by those skilled in the art, as also expressed, e.g., by Barth [18] on pg.2, col.2, lines 22-25.

Applicant has no response to the Examiner's conflict as to whether he should argue philosophy or not, or whether he thinks it is irrelevant or not. Once the Examiner takes a position, Applicant can respond.

Regardless, the results of the double-slit experiment, they are derived in closed-form equations from physical laws and appear in Chp. 8 Mills GUT. The double-slit experiment for the electron is also solved classically in Chp. 8, and the computer animation is available at:

http://www.blacklightpower.com/theory/theory.shtml

Section 109

Examiner Souw further states on Appendix page 37:

> For all the reasons stated above, Applicant's contention that the conventional QM is in "serious trouble" because it allegedly entails unsolvable paradoxes and inconsistencies, hence, needs to be rejected and/or drastically revised, is totally unpersuasive.

The Examiner provides no remedy to the paradoxes of SQM which even he exposes. Rather than address them, he chooses to ignore them in a smoke screen of fluid, contradictory philosophical and metaphysical views. Why is not the existence of paradoxes grounds to even question the validity of SQM? Why is a PTO Examiner even mired in such issues? Why is he wasting Applicant's time with such existential issues? Is this practice widespread or limited to the present Applicant? Is it because Applicant used physics to solve the atom exactly and this is embarrassing to SQM practitioners who espouse virtual particles, "spooky actions", infinities, compactified dimensions and other such fantasies? Is the Examiner trying to coerce inventors to adhere to his philosophies/religion?

With CQM, philosophical issues do not exist. It is predictive. So, why is Applicant's invention not being reviewed based on the merits and real-world data? Why the obfuscation based on the presumption that SQM is the correct theory of nature when quantum aficionados including the Examiner are incapable of characterizing reality according SQM?

The Examiner has failed to answer any of these questions.

Section 110

Examiner Souw's arguments on page 37 of his Appendix regarding spin are also without merit:

> **8. Applicant's confusion regarding electron spin**
>
> Applicant has failed to address the Examiner's refutation in the previous Appendix. Applicant's spin wave function as postulated (but not derived) in GUT and repeated on pg.65-69 is mathematically flawed, since it contains mathematical inconsistencies and self-contradictions, as discussed in the previous Appendix (sect.6/pg.5-7), and more specifically in section 6 above. The Stern-Gerlach experiment has been adequately explained by Goudsmit and Uhlenbeck based on electron spin, which theoretically also agrees with the Pauli theory that represents the wavefunctions of a particle with spin 1/2 as 2-dimensional column-vector functions, $ø^+$ and $ø^-$, known in the art as Pauli wave functions [3,7]. These Pauli functions have been previously shown to be in perfect agreement with the spin functions **á** and **â** defined by Applicant's own cited reference [1]. These, however, turned out to disagree with Applicant's statement and formulations, as described above in section 6.

Not only has Applicant derived the spin function in Chp 1 and Appendix III of Mills GUT, he as also produced computer simulations that can assist the Examiner in unequivocally understanding Applicant's solution:

http://www.blacklightpower.com/theory/theory.shtml (under "Computation Files")

The results of the closed-form equations that contain fundamental constants only can not be matched by SQM. The spin function of SQM is postulated and is not predictive. It is not correct. It is nonphysical since current can not exist in zero dimensions. It posses infinite magnetic-field energy, and it misses the g factor

example. Whereas, Applicant's CQM calculation matches observations to 11 figure accuracy (see Sections 88 and 92 above), the maximum limit possible based on the experimental error in the fine structure constant (the only parameter).

Section 111

Examiner Souw repeats previous errors in his arguments appearing on Appendix pages 37-38:

> Therefore, the Stern-Gerlach experiment does not need Applicant's explanation; not only because the underlying theory is incredible, but also because the explanation and prediction provided by the conventional QM is far more superior, far more quantitative and accurate, and --without falling into self-contradiction-- far more comprehensive than what Applicant has to offer. In this regard, Applicant's attempt to defend his derivation of spin-orbital wave function by combining the spin and orbital functions in one single function of (r,t) has been proven to be based on a misunderstanding over his own reference McQuarrie [1], specifically with regard to Pauli eigenfunctions, as described above and in section 6. A correct interpretation of this Pauli eigenfunctions has been demonstrated by the Examiner by successful application of the conventional QM, as evidenced by elaborate mathematical calculations of intricate line splitting and intensities that have been experimentally verified to be extremely accurate to better than 10^{-5} nm [3]. This accuracy is far more superior to the 0.1 nm accuracy of Applicant's measurements. Accordingly, Applicant's argument regarding this subject matter is totally unpersuasive.

These arguments are redundant of those found in other sections in this Response.

The current (SQM) explanation of the Stern-Gerlach experiment is postulated and physically impossible (current in zero dimensions), and it is not predictive as discussed above. CQM is in a league of its own in that is gives an exact current distribution that reproduces all of the observations related to spin with extreme accuracy.

Section 112

Examiner Souw further argues on Appendix page 38 that:

9. Regarding "Applicant's hydrogen wave function is seriously flawed"

Similar to most of his other remarks, here Applicant does not even try to refute the Examiner's arguments as presented in the previous Appendix, but merely re-iterate his position as already presented in his evidently flawed GUT. The incredibly-large amount of mathematical flaws and incorrect understanding of physical principles ultimately disqualifies the GUT as a scientific theory. Every argument based on GUT is therefore unpersuasive.

That the Examiner admits that Applicant has a GUT concedes a triumph over SQM which is incompatible with General Relativity and has dismaly failed in unifying physics for over 80 years. The failure to find the predicted Higgs bosom to account for the masses of fundamental particles and the disproof of the HUP by the Hubble images are just the latest in the string of failures of SQM with decades of wasted manpower and billions of wasted taxpayer dollars. While it may be difficult, the Examienr must face this fact.

In contrast, in addition to precisely predicting atomic observables in closed-form exact equations with fundamental constants only—a feat never achieved by SQM for a single example—CQM unifies the physical laws as discussed in Mills GUT (Ref. #1):

QUANTUM THEORY PAST AND FUTURE

The Schrödinger equation was originally postulated in 1926 as having a solution of the one-electron atom. It gives the principal energy levels of the hydrogen atom as eigenvalues of eigenfunction solutions of the Laguerre differential equation. But, as the principal quantum number n>>1, the eigenfunctions become nonsensical. Despite its wide acceptance, on deeper inspection, the Schrodinger solution is plagued with many failings as well as difficulties in terms of physical interpretations that have caused it to remain controversial since its inception. Only the one-electron atom may be solved without approximations, but it fails to predict electron spin, leads to models with nonsensical consequences such as negative energy states of the vacuum, infinities, and negative kinetic energy, and it fails to predict the stability of the atomic hydrogen $n = 1$ state except for an arbitrary definition[28] [5, 17, 53, 58, 80, 94, 102, 106, 107]. In addition to many predictions which simply do not agree with observations even

[28] The Schrodinger equation can only yield integer eigenvalue solutions by selection or definition from an infinite number of possibilities since the solution is over all space with no boundary (i.e. 0 to ∞). In contrast, wave equation solutions with integers are common for boundary constrained systems such as waveguides and resonators.

regarding the one-electron atom [5, 17, 53, 58, 80, 94, 102, 106, 107], the Schrödinger equation predicts noncausality, nonlocality, spooky actions at a distance or quantum telepathy, perpetual motion, and many internal inconsistencies where contradicting statements have to be taken true simultaneously. Recently, the behavior of free electrons in superfluid helium has again forced the issue of the meaning of the wavefunction. Electrons form bubbles in superfluid helium which reveal that the electron is real and that a physical interpretation of the wavefunction is necessary. Furthermore, when irradiated with light of energy of about a 0.5 to several eV [111], the electrons carry current at different rates as if they exist with different sizes. It has been proposed that the behavior of free electrons in superfluid helium can be explained in terms of the electron breaking into pieces at superfluid helium temperatures [111]. Yet, the electron has proven to be indivisible even under particle accelerator collisions at 90 GeV (LEPII). The nature of the wavefunction must now be addressed. It is time for the physical rather than the mathematical nature of the wavefunction to be determined.

A classical quantum mechanics (CQM) theory is herein derived from first principles that successfully applies physical laws on all scales. CQM gives closed form physical solutions for the electron in atoms, the free electron, and the free electron in superfluid helium. The prediction of fractional principal quantum energy states of the electron in liquid helium match the photoconductivity and mobility observations without requiring that the electron is divisible [17, 53].

In CQM, the classical wave equation is solved with the constraint that a bound electron cannot radiate energy. The mathematical formulation for zero radiation based on Maxwell's equations follows from a derivation by Haus [108]. The function that describes the motion of the electron must not possess spacetime Fourier components that are synchronous with waves traveling at the speed of light. CQM gives closed form solutions for the atom including the stability of the $n = 1$ state and the instability of the excited states, relativistic invariance of the wave equation, the equations of the photon and electron in excited states, and the equations of the free electron and photon which also predict the wave-particle duality behavior of particles and light. The current and charge-density functions of the electron may be directly physically interpreted. For example, spin angular momentum results from the motion of negatively charged mass moving systematically, and the equation for angular momentum, $\mathbf{r} \times \mathbf{p} = \hbar$, can be applied directly to the wave function (a current-density function) that describes the electron. A partial listing of well-known and documented phenomena which are derivable in closed form from CQM based on Maxwell's equations are given in Table 1. The calculations agree with experimental observations.

Table 1. Partial List of Physical Phenomena Solved by CQM.

• Stability of the atom to radiation	• Compton effect
• Magnetic moment of a Bohr magneton and relativistic invariance of each of $\frac{e}{m_e}$ of the electron, the electron angular momentum of $\hbar$, and the electron magnetic moment of μ_B from the spin angular momentum	• Wave-particle duality
• Stern Gerlach experiment	• Double-slit experiment for photons and electrons
• Electron and muon g factors	• Davisson Germer experiment
• Rotational energies and momenta	• Elastic electron scattering from helium atoms
• Reduced electron mass	• Ionization energies of multielectron atoms
• Ionization energies of one-electron atoms	• Hydride ion binding energy and absolute NMR shift
• Special relativistic effects	• Excited states of the helium atom
• Excited states	• Proton scattering from atomic hydrogen
• Resonant line width and shape	• Nature of the chemical bond
• Selection rules	• Bond energies, vibrational energies, rotational energies, and bond distances of hydrogen-type molecules and molecular ions, absolute NMR shift of H_2
• Correspondence principle	• Superconductivity and Josephson junction experiments
• Orbital and spin splitting	• Integral and fractional quantum Hall effects
• Stark effect	• Aharonov-Bohm effect
• Lamb Shift	• Aspect experiment
• Knight shift	• Durr experiment on the Heisenberg Uncertainty Principle
• Spin-orbital coupling (fine structure)	• Penning trap experiments on single ions
• Spin-nuclear coupling (hyperfine structure)	• Hyperfine structure interval of positronium
• Hyperfine structure interval of muonium	• Magnetic moments of the nucleons
• Nature of the free electron	• Beta decay energy of the neutron
• Nature of the photon	• Binding energy of deuterium
• Photoelectric effect	• Alpha decay

For any kind of wave advancing with limiting velocity and capable of transmitting signals, the equation of front propagation is the same as the equation for the front of a light wave. By applying this condition to electromagnetic and gravitational fields at

particle production, the Schwarzschild metric (SM) is derived from the classical wave equation which modifies general relativity to include conservation of spacetime in addition to momentum and mass-energy. The result gives a natural relationship between Maxwell's equations, special relativity, and general relativity. It gives gravitation from the atom to the cosmos. The universe is time harmonically oscillatory in matter, energy, and spacetime expansion and contraction with a minimum radius that is the gravitational radius. A partial listing of the particle and cosmological phenomena derivable from CQM in closed form equations with fundamental constants only is given in Table 2.

Table 2. Partial List of Particle and Cosmological Phenomena Solved by CQM.

• Deflection of light by stars	• Power spectrum of the universe
• Precession of the perihelion of Mercury	• Microwave background temperature
• Lepton masses	• Uniformity of the microwave background radiation
• Quark masses	• Microkelvin spatial variation of the microwave background radiation measured by DASI
• Hubble constant	• Polarization of DASI data
• Age of the universe	• Observed violation of the GZK cutoff
• Observed acceleration of the expansion	• Mass density of the universe
• Power of the universe	• Large scale structure of the universe

CQM further gives the identity of dark matter which matches the criteria for the structure of galaxies and spectral lines from interstellar medium and the Sun which have been observed in the laboratory [28, 33-36, 50, 63, 67, 71, 73, 75-76, 78, 86-87, 90]. In a special case wherein the gravitational potential energy density of a blackhole equals that of the Planck mass, matter converts to energy and spacetime expands with the release of a gamma ray burst. The singularity in the SM is eliminated.

After decades of futility, QM and the Heisenberg Uncertainty Principle have not yielded a unified theory, are still purely mathematical, and have yet to be shown to be based in reality[29] [5, 17, 53, 58, 80, 94, 102, 106, 107]. Both are based on circular

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[29] From the time of its inception, quantum mechanic (QM) has been controversial because its foundations are in conflict with physical laws and are internally inconsistent. Interpretations of quantum mechanics such as hidden variables, multiple worlds, consistency rules, and spontaneous collapse have been put forward in an attempt to base the theory in reality. Unfortunately many theoreticians ignore the requirement that the wave function must be real and physical in order for it to be considered a valid description of reality. For example, regarding this issue Fuchs and Peres believe [112] "Contrary to those desires, quantum theory does *not* describe physical reality. What it does is provide an algorithm for computing *probabilities* for macroscopic events ("detector ticks") that are the consequences of our experimental interventions. This strict definition of the scope of quantum theory is the only interpretation ever needed, whether by experimenters or theorists."

With Penning traps, it is possible to measure transitions including those with hyperfine levels of electrons of

single ions. This case can be experimentally distinguished from statistics over equivalent transitions in many ions. Whether many or one, the transition energies are always identical within the resonant line width. So, *probabilities* have no place in describing atomic energy levels. Moreover, quantum theory is incompatible with probability theory as discussed previously [17, 107].

The Copenhagen interpretation provides another meaning of quantum mechanics. It asserts that what we observe is all we can know; any speculation about what an electron, photon, atom, or other atomic-sized entity is really or what it is doing when we are not looking is just that—speculation. The postulate of quantum measurement asserts that the process of measuring an observable forces it into a state of reality. In other words, reality is irrelevant until a measurement is made. In the case of electrons in helium, the fallacy with this position is that the "ticks" (migration times of electron bubbles) reveal that the electron is real before a measurement is made [17, 107]. Furthermore, experiments on Ba^{+} in a Penning trap discussed in the Inconsistencies of Quantum Mechanics section demonstrate that the postulate of quantum measurement of quantum mechanics is experimentally disproved. These issues and other such flawed philosophies and interpretations of experiments that arise from quantum mechanics are discussed in the Retrospect section and Ref. [17, 80, 107].

QM gives correlations with experimental data. It does not explain the mechanism for the observed data. But, it should not be surprising that it gives good correlations given that the constraints of internal consistency and conformance to physical laws are removed for a wave equation with an infinite number of solutions wherein the solutions may be formulated as an infinite series of eigenfunctions with variable parameters. There are no physical constraints on the parameters. They may even correspond to unobservables or "flights of fantasy" such as probability waves, virtual particles, negative energy of the vacuum, polarization of the vacuum by virtual particles, infinities, renormalization, effective nuclear charge, ionic terms in the perturbation series, fermion propagators, virtual photon annihilation, virtual photon emission and reabsorption, virtual electron positron annihilation, photon propagators, plethora of postulated super-symmetry virtual particles which make contributions such as smuon-neutralino and sneutrino-chargino loops, neutrino oscillation, worm holes, parallel universes, hyperdimensions, parallel mind universes, quantum telepathy, entanglement, spooky actions at a distance, faster than light travel, dark energy, exotic particles comprising dark matter, the universe from nothing, big bang-inflation-deceleration-reacceleration of the universe, and so on and so on. With mathematics, it is possible to represent an infinite number of models with limitless fantasy. If you invoke the constraints of internal consistency and conformance to physical laws, quantum mechanics has never successfully solved a physical problem.

Throughout the history of quantum theory, wherever there was an advance to a new application, it was necessary to repeat a trial and error experimentation to find which method of calculation gave the right answers. Often the textbooks present only the successful procedure as if it followed from first principles; and do not mention the actual method by which it was found. In electromagnetic theory based on Maxwell's equations, one deduces the computational algorithm from the general principles. In quantum theory, the logic is just the opposite. One chooses the principle to fit the empirically successful algorithm. For example, we know that it required a great deal of art and tact over decades of effort to get correct predictions out of Quantum Electrodynamics (QED). For the right experimental numbers to emerge, one must do the calculation (i.e. subtract off the infinities) in one particular way and not in some other way that appears in principle equally valid. There is a corollary, noted by Kallen: from an inconsistent theory, any result may be derived.

Reanalysis of old experiments and many new experiments including electrons in superfluid helium challenge the Schr\O(o,¨)dinger equation predictions. Many noted physicists rejected quantum mechanics. Feynman also attempted to use first principles including Maxwell's Equations to discover new physics to replace quantum mechanics [113]. Other great physicists of the 20th century searched. "Einstein [...] insisted [...] that a more detailed, wholly deterministic theory must underlie the vagaries of quantum mechanics" [114]. He felt that scientists were misinterpreting the data. Examples of quantum mechanical misinterpretations of experiments are:

1.) The rise in current of free electrons in superfluid helium when irradiated with low-energy light and the formation of an unexpected plethora of exotic negative charge carriers in superfluid helium with mobilities greater than that of the normal electron are due to the electron breaking into fractional pieces.

2.) Virtual particles surround the electron, and as the electron's center is approached, they shield the electron's charge less effectively.

3.) Spooky actions at a distance are predicted.

4.) The purely postulated Hund's Rule and the Pauli Exclusion Principle of the assignment of unique quantum numbers to all electrons are "weird spooky action" phenomena unique to quantum mechanics that require all electrons in the universe to have instantaneous communication and coordination with no basis in physical laws such as Maxwell's equations.

5.) Since fundamental particles are probability waves and their position and energy are uncertain according to the Uncertainty Principle, they can "magically" appear on the other side of a supposedly insurmountable energy barrier based on their energy on the initial side of the barrier. Thus, they defy physical laws and tunnel through the barrier.

6.) A $^{9}Be^{+}$ ion may be in two separate locations at once.

7.) Supercurrent may go in both directions at once.

8.) Perpetual motion is predicted.

9.) A weak force is observed between the two precision machined plates with minuscule separation because the plates serve to limit the number of virtual particle modes between the plates as opposed to those outside the plates and the resulting imbalance in pressure between two infinite quantities gives rise to the feeble force known as the Casimir effect.

10.) The *postulated* Quantum Electrodynamics (QED) theory of $\frac{g}{2}$ is based on the determination of the terms of a *postulated* power series in α / π where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term. The algorithm involves scores of *postulated* Feynman diagrams corresponding to thousands of matrices with thousands of integrations per matrix requiring decades to reach a consensus on the "appropriate" *postulated* algorithm to remove the intrinsic infinities.

11.) The muon g factor g_μ is required to be different from the electron g factor in the standard model due to the mass dependent interaction of each lepton with vacuum polarizations due to virtual particles. The BNL Muon (g-2) Collaboration used a "magic" $\gamma = 29.3$ which satisfied the BMT equation identically for the theoretical value of $\frac{g_\mu}{2}$ with assumption that $\frac{g_\mu}{2} \neq \frac{g_e}{2}$ and obtained a measured result that was internally consistent.

12.) The expansion of the universe is accelerating due to the presence of "dark energy" throughput all space.

13.) According to Nesvizhevsky et al. [115], a step in the transmission of falling neutrons through a variable-height channel comprising a mirror on the bottom and an absorber at the top occurred at a height of $13\ \mu m$ because neutrons fell in quantized jumps.

14.) The lowest energy vibrational state of any molecule is not zero rather, in violation of the second law of thermodynamics and experimental observation such as the formation of a Bose-Einstein condensate of molecules, it is the zero order vibration of $\frac{1}{2} h\nu = \frac{1}{2}\sqrt{\frac{k}{\mu}}$ that is equivalent to zero point energy.

15.) Since flux is linked by a superconducting loop with a weak link in quantized units of the magnetic flux quantum, $\Phi_0 = \frac{h}{2e}$, the basis of superconductivity is interpreted as arising from the formation of electron pairs corresponding to the $2e$ term in the denominator; the so-called Cooper pairs form even though electrons repel each other, the electron repulsion should increase the resistance to electron flow, and such pairs can not form at the critical temperature of high T_c superconductors.

***THEN THERE IS REALITY*:**

1.) Fractional principal quantum energy states of the electron in liquid helium match the photoconductivity and mobility observations without requiring that the electron is divisible.

2.) The electron is an extended particle rather than a point, and the charge-density is greatest in the center.

3.) Photon momentum is conserved on a photon by photon basis rather than statistically as predicted by quantum mechanics which predicts photon coincidence counts at separated detectors (Aspect experiment).

4.) The observations that all electrons have unique quantum numbers and that the electron configuration of atoms follows a pattern based on solutions of Laplace's equation are phenomenological consequences of physical laws such as Maxwell's equations.

5.) Fundamental particles such as an electron are real, extended particles, each of size equal to its de Broglie wavelength rather than a point-particle-probability-wave. Potential energy is gained as the particle traverses the barrier which is cleared; even though, its initial kinetic energy was less than the barrier height. Energy conservation is obeyed at all times. Tunneling arises from physical laws.

6.) The fluorescence emission spectrum of a Penning trapped ${}^{9}Be^{+}$ ion shows interference peaks due to coupling between oscillator modes and a Stern Gerlach transition.

7.) The energy difference of a superconducting loop observed by Friedman et al. matches the energy corresponding to the flux linkage of the magnetic flux quantum by the ensemble of superconducting electrons in their entirety with a reversal of the corresponding macroscopic current.

8.) Perpetual motion is not permitted or observed.

9.) The Casimir effect is predicted by Maxwell's equations wherein the attractive force is due only to the interactions of the material bodies themselves. Charge and current fluctuations in a material body with a general susceptibility serve as source terms for Maxwell's equations, i.e. classical fields, subject to the boundary conditions presented by the body surfaces. In the limiting case of rarefied media, the van der Waal force of interaction between individual atoms is obtained.

10.) The remarkable agreement between Eqs. (1.204) and (1.205) of the Electron g Factor section demonstrates that $\frac{g}{2}$ may be derived in closed form from Maxwell's equations in a simple straight forward manner that yields a result with eleven figure agreement with experiment—the limit of the experimental capability of the measurement of the fundamental constants that determine α.

11.) Rather than indicating an expanded plethora of postulated super-symmetry virtual particles which make contributions such as smuon-neutralino and sneutrino-chargino loops, the muon, like the electron, is a lepton with $\hbar$ of angular momentum, and the muon and electron g factors are predicted by CQM to be identical. Using the experimental "magic" $\gamma = 29.3$ and $\frac{g_\mu}{2} = \frac{g_e}{2}$ in the BMT equation, the predicted measurement exactly matched $\frac{g_\mu}{2}$ measured by the BNL Muon (g-2) Collaboration proving that their assumption that the $\gamma = 29.3$ condition eliminated the effect of the electrostatic field on ω_a was flawed and showed the equivalence of the muon and electron g factors.

12.) The constant maximum speed, c, for the propagation of light and gravity results in the conservation relationship of mass-energy, $E = mc^2$ and spacetime, $\frac{c^3}{4\pi G} = 3.22\ X\,10^{34}\ \frac{kg}{\sec}$. Spacetime expands as mass is converted to energy, and the predictions match the observed Hubble constant and the acceleration of the expansion.

13.) The de Broglie wavelength in the vertical direction corresponding to the scattering of a falling neutron from the mirror

arguments that the electron is a probability wave requiring that the electron have multiple positions and energies including negative and infinite energies simultaneously. Both are postulated, cannot be proven experimentally, and predict consequences such as violation of conservation of energy and momentum and an essentially infinite cosmological constant [17, 80, 102, 106, 107] and Ref. [116]. These predictions are not in agreement with experimentation. Furthermore, it was recently proven experimentally that the Heisenberg Uncertainty principle has nothing to do with wave-particle duality as shown in Refs. [17, 80, 107], the Wave-Particle Duality is Not Due to the Uncertainty Principle section, and Ref. [117]; whereas, the opposite is largely touted as one of its triumphs.

In contrast, the predictions of CQM are unprecedented in that agreement with observations is achieved over 85 orders of magnitude from the scale of fundamental particles to that of the cosmos. Observable features of atomic particles such as the electron g factor may be calculated in closed form from Maxwell's equations with 11 figure accuracy without invoking the vagaries and inconsistencies inherent with QM and the Heisenberg Uncertainty Principle.

OUTLINE OF THE RESULTS OF THE UNIFIED THEORY DERIVED FROM FIRST PRINCIPLES

To overcome the limitations of quantum mechanics, physical laws which are exact on all scales are sought. Rather than engendering the electron with a wave nature as suggested by the Davisson-Germer experiment and fabricating a set of

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to the absorber was given by $\lambda = z_1 = \frac{1}{2}\left(\frac{h}{m_n}\right)^{2/3}(g)^{-1/3} = 12.6\ \mu m$ where h is Planck's constant, m_n is the mass of the neutron, and g is the acceleration due to gravity. For absorber heights greater than $13\ \mu m$, the height was greater than the de Broglie wavelength; thus, a step in the transmission of failing neutrons occurred at $13\ \mu m$. The observed transmission matched identically that predicted by Newton's Law of Gravitation; no quantum gravity effect was observed.

14.) The lowest energy vibrational state of any molecule is zero as its lowest vibrational and rotational energies, and the molecules can be solved using first principles in closed form equations in agreement with experimental observations including the difference in bond energies and vibrational energies with isotopes substitution.

15.) To conserve the electron's invariant angular momentum of $\hbar$, flux is linked by each electron in quantized units of the magnetic flux quantum, $\Phi_0 = \frac{h}{2e}$, and the basis of superconductivity is a correlated flow of an ensemble of individual electrons such that no energy is dissipated (i.e. superconductivity arises when the lattice is a band-pass for the magnetic field of an array of magnetic dipoles; so, no energy is dissipated with current flow).

CQM explains the data based on reality versus fantastical interpretations of probability wave equation solutions. These examples are given in Appendix II: Quantum Electrodynamics is Purely Mathematical and Has No Basis in Reality, Appendix IV: Muon g Factor, the Retrospect section, the Gravity section, and Refs. [5, 17, 53, 58, 80, 94, 102, 106, 107]. Tunneling phenomena are derived in the Alpha Decay section and the Schrödinger Fat Cats—Another Flawed Interpretation section.

associated postulates and mathematical rules for wave operators, a new theory is derived from first principles.

Foundations:

- Physical laws apply on all scales (especially Maxwell's)
- Absolute internal consistency even between widely different phenomena,
- Conservation of linear and angular momentum,
- Charge conservation,
- First and second law of thermodynamics,
- Constant maximum of the speed of light in a vacuum,
- Special relativity with Newton's laws in the low speed limit,
- Conservation of matter/energy,
- General relativity derived from Maxwell's equations using the constant maximum propagation of any signal including the gravitational field which gives the Schwarzschild metric and conservation of spacetime as well as matter/energy with no cosmological constant; Newtonian gravitation in the weak field limit which forbids a cosmological constant,
- A vacuum is a vacuum,
- 4 dimensional spacetime, and
- The only allowed parameters are the measured fundamental constants.

The novel theory of Classical Quantum Mechanics (CQM) unifies Maxwell's Equations, Newton's Laws, and General and Special Relativity. The closed form calculations of a broad spectrum of fundamental phenomena containing fundamental constants only are given in subsequent sections. CQM gives closed form solutions for the atom which give four quantum numbers, the Rydberg constant, the stability of the $n=1$ state and the instability of the excited states, relativistic invariance of the wave equation, the equations of the photon and electron in excited states, the equations of the free electron, and photon which predict the wave particle duality behavior of particles and light. The current and charge-density functions of the electron may be directly physically interpreted. For example, spin angular momentum results from the motion of negatively charged mass moving systematically, and the equation for angular

momentum, $\mathbf{r} \times \mathbf{p} = \hbar$, can be applied directly to the wave function (a current-density function) that describes the electron. The magnetic moment of a Bohr magneton, Stern Gerlach experiment, electron and muon g factors, fine structure splitting, Lamb shift, hyperfine structure, muonium hyperfine structure interval, resonant line width and shape, selection rules, correspondence principle, wave particle duality, excited states, reduced mass, rotational energies and momenta, spin-orbital coupling, Knight shift and spin-nuclear coupling, closed form solutions for one, two, and three electron atoms, excited states of the helium atom, elastic electron scattering from helium atoms, proton scattering from atomic hydrogen, the nature of the chemical bond, bond energies, vibrational energies, rotational energies, and bond distances of hydrogen-type molecules and molecular ions, Davisson Germer experiment, Aspect experiment, Durr experiment on the Heisenberg Uncertainty Principle, Penning trap experiments on single ions, hyperfine structure interval of positronium, magnetic moments of the nucleons, beta decay energy of the neutron, the binding energy of deuterium, and alpha decay are derived in closed form equations based on Maxwell's equations. The theory of collective phenomena including statistical mechanics, superconductivity and Josephson junction experiments, integral and fractional quantum Hall effects, and the Aharonov-Bohm effect is given. The calculations agree with experimental observations.

From the closed form solution of the helium atom, the predicted electron scattering intensity is derived. The closed form scattering equation matches the experimental data; whereas, calculations based on the Born model of the atom utterly fail at small scattering angles. The implications for the invalidity of the Schrödinger and Born models of the atom and the dependent Heisenberg Uncertainty Principle are discussed.

For any kind of wave advancing with limiting velocity and capable of transmitting signals, the equation of front propagation is the same as the equation for the front of a light wave. By applying this condition to electromagnetic and gravitational fields at particle production, the Schwarzschild metric (SM) is derived from the classical wave equation which modifies general relativity to include conservation of spacetime in addition to momentum and matter/energy. The result gives a natural relationship between Maxwell's equations, special relativity, and general relativity. It gives gravitation from the atom to the cosmos. The gravitational equations with the equivalence of the particle production energies permit the equivalence of mass-energy and the spacetime wherein a *"clock" is defined that measures "clicks" on an observable in one aspect, and in another, it is the ruler of spacetime of the universe with the implicit dependence of spacetime on matter-energy conversion.* The masses of the leptons, the quarks, and nucleons are derived from this metric of spacetime. The universe is time harmonically oscillatory in matter, energy, and spacetime expansion and contraction with a minimum radius that is the gravitational radius. In closed form equations with fundamental constants only, CQM gives the basis of the atomic, thermodynamic, and cosmological arrows of time, the deflection of light by stars, the

precession of the perihelion of Mercury, the Hubble constant, the age of the universe, the observed acceleration of the expansion, the power of the universe, the power spectrum of the universe, the microwave background temperature, the primary uniformity of the microwave background radiation, the polarization and microkelvin temperature spatial variation of the microwave background radiation measured by DASI, the observed violation of the GZK cutoff, the mass density of the universe, the large scale structure of the universe, and the identity of dark matter which matches the criteria for the structure of galaxies and spectral lines from interstellar medium and the Sun which have been observed in the laboratory [25-26]. In a special case wherein the gravitational potential energy density of a blackhole equals that of the Planck mass, matter converts to energy and spacetime expands with the release of a gamma ray burst. The singularity in the SM is eliminated.

Section 113

Examiner Souw repeats the following previously flawed arguments on pages 38-39 of his Appendix:

> **10. Regarding Applicant's incorrect application of Einstein's Special Relativity**
>
> Applicant's repeat of his GUT derivation is unpersuasive, since it does not address the Examiner's point of refutation as brought up the previous Appendix. The Examiner's refutation was/is, that Applicant's application of Einstein's Relativity Theory to an orbiting electron is fundamentally wrong, since such a system is not an inertial system, and hence, the Lorentz contraction is not applicable. There appears to be a lack of appreciation by the applicant of the crucial difference between inertial systems and non-inertial systems, which is most fundamental to Einstein's Relativity Theory. Therefore, Applicant's entire argument is unpersuasive.

These arguments are redundant of those rebutted in previous Sections of this Response (see, e.g., Sections 55 and 81 above).

Section 114

Examiner Souw asserts on page 39 of his Appendix that:

> **11. Applicant's failure to respond to specific refutations in the original Souw Appendix**

Besides Applicant's failure to persuasively argue against the Examiner's refutation of GUT as raised in the original Appendix, Applicant has left these points un-responded:

(a) Applicant's misinterpretation of the radial function in QM that allegedly goes straight through the nucleus, which is raised by the Examiner in sect. 9 of the original Appendix.

According to SQM textbooks, the electron is in the nucleus. A theory of the hydrogen atom can not be correct if it requires that the electron is in the nucleus. Thus, SQM is fatally flawed as discussed in Ref. # 17 and 80. A valid theory can not permit the electron to "spiral into the nucleus". However, an inescapable fact of SQM is that the wave function solution of the SE requires that **the electron is in the nucleus** [17, 80]. In fact, the electron must exist in the nucleus since the wave function is a maximum there. This is clearly claimed in the literature as discussed by Karplus to explain the spin-nuclear coupling called Fermi contact interaction for example [M. Karplus and R. N. Porter, *Atoms and Molecules an Introduction for Students of Physical Chemistry*, The Benjamin/Cummings Publishing Company, Menlo Park, California, (1970), p. 567]. In fact, the probability density function Ψ^2 has a maximum at the nucleus for the n=1 state, and the nucleus has a finite volume. Griffiths gives the time average that the electron is in the nucleus [D. J. Griffiths, *Introduction to Quantum Mechanics*, Prentice-Hall, (1995), Prob. 4.14]. This situation corresponds to infinite energy using Feynman's correct assertion [80] that the Coulomb potential must apply to the interaction of the electron and the nucleus.

Section 115

Examiner Souw further repeats previously rebutted arguments on Appendix page 39:

(b) The Examiner's invitation for Applicant to use his GUT to calculate line intensities that are verifiable by experimental measurement, as done by the examiner in his two cited own works [3, 4] remains un-responded.

These arguments are redundant having already been disposed of in Section 59 above.

Section 116

Examiner Souw concludes his error-plagued Appendix with additional erroneous statements on pages 39-40:

Conclusion:

> Applicant's response has failed to remove the Examiner's points of refutation as brought in the original Souw Appendix, some of which having been improperly addressed, or even left-out un-addressed. Consequently, all points of the Examiner's refutation remain in force, and are re-instated herein by incorporation, in addition to the above new proofs of Applicant's errors and misunderstanding brought up in his response(s). The Examiner does not evaluate GUT from an exclusive viewpoint of QM, as alleged by Applicant, but takes account of the fact that GUT is trying to disagree with QM, i.e., by fully considering every point of Applicant's arguments. Thus, the Examiner has evaluated the GUT on its own merit based on its scientific credibility, i.e., its validity with regard to mathematical basis and experimental evidence. It was found, none of the criteria required by the conventional standard for scientific theory and/or patentable invention has been fulfilled.

As indicated by the independent reviews listed above in Section 54 and some of the stunning results of closed-form equations presented above in Sections 54-55 and the attached tables:

Tables summarizing the results of the calculated and experimental parameters of H_2, D_2, H_2^+ and D_2^+, one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, and twenty-electron atoms, the excited states of helium, the electron g factor, and relations between fundamental particles. The closed-form derivations from Maxwell's equations given in

The Grand Unified Theory of Classical Quantum Mechanics posted at http://www.blacklightpower.com/bookdownload.shtml

contain fundamental constants only. The nature of the chemical bond is given in Chp. 12. The atoms are solved exactly in Chps. 1, 7, and 10. The excited states of helium are solved exactly in Chp. 9. The electron g factor and relations between fundamental particles are given in Chp. 1 and Chps. 27 and 30, respectively.

These results can not be replicated by SQM, nor can CQM's extraordinary predictiveness. The successes over 85 orders of magnitude of scale demonstrate that CQM is the correct physics of nature from the scale of the quarks to the cosmos. It successfully predicted the mass of the top quark, the acceleration of the expansion of the universe, and the characteristics of hydrino that have been verified in over 112 journal articles and 51 independent reports and journal articles.

The Examiner is blinded by his biases that he can not even appreciate. His argument that he is applying physical laws while defending the validity of the HUP is contradictory and indicative of his bias or incapacity to understand the conflict. Even more troubling is the Examiner's degradation to philosophical and metaphysical debates. This is inappropriate for a PTO official and has unfairly delayed allowance of this case.

Section 117

Examiner Souw further errouneously argues on Appendix page 4 that:

On pages 105-106 of applicant's 188 page response filed on 10/22/2004, applicant asserts that there is an enormous body of additional theoretical support that applicant has submitted for the new states of hydrogen and that the applicant has provided an enormous body of experiment evidence that lower-energy hydrogen states are produced by the disclosed catalytic reaction. However, this assertion is unrelated to the

> Examiner's argument that there is no theoretical or experimental support for new forms of one electron atoms having an atomic mass of at least four and having an increased binding energy greater than the binding energy of the corresponding ordinary one electron atom because these new forms of one electron atoms having an atomic mass of at least four are not hydrino atoms. Nevertheless, since applicant uses the same mathematically and scientifically flawed theory of the hydrino atom as theoretical support for one-electron atoms having an atomic mass of at least four and having an increased binding energy greater than the binding energy of the corresponding ordinary one electron atom, the Examiner remains unpersuaded that these novel forms of one electron atoms are theoretically supported or actually exist for the same reasons of record given for the hydrino atom.

Given the overwhelming body of evidence for hydrino (lower-energy states of a one-electron atom) cited in the 112 journal articles and 51 independent reports and journal articles, as well as the unprecedented predictability of the Mills GUT as discussed above, including Sections 54-55, 69-70, 112 and 115, the existence of the general case of lower-energy states of one-electron atoms is also established.

Section 118

Examiner Souw again errs in stating on page 4 of the Appendix that:

> On page 111 of the response, applicant asserts that there is no contradiction with respect to the enthalpy of reaction of the catalyst ~ throughout his specification. The Examiner remains unpersuaded because the applicant is now introducing new matter and arbitrary values into his postulated equations (not derived as explained in previous Office Actions) in order to explain his contradictions in his original disclosure.

Applicant has adequately and consistently disclosed the enthalpy of reaction of the catalyst throughout his specification. The two possibilities of m/2X27.2 eV and mX27.2 eV, where in both cases m is an integer, are subsets of each other. This allows for the possibility that: (1) the catalyst increases the central-field interaction by an integer followed by a further release of energy of an integer multiple of 13.6 eV as derived in Mills GUT and disclosed in the specification; (2) provides for the possibility that multiple species each with an ionization energy of 13.6 eV such as atomic

hydrogen or oxygen can serve as the catalyst in aggregate, and (3) the possibly that the catalyst accepts the entire energy of the transition between the initial and final states. An example of a catalyst of case (3) for the transition between the n=1 to the n=1/2 states of atomic hydrogen that was presented in the last Response of 10/22/04 is Ne+.

For all of the foregoing reasons, Examiner Souw's rejections should be withdrawn and this case allowed.